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Earth and Life Upon It

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NEW · PATHWAYS · IN · SCIENCE

The Earth and Life Upon It

By

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New Pathways in Science

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We Want to Know
CRAIG · BURKE · BABCOCK

▪

We Find Out
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▪

Changes All Around Us
CRAIG · BALDWIN

▪

Our Earth and Sky
CRAIG · BALDWIN

▪

The Earth and Life Upon It
CRAIG · HURLEY

▪

From Sun to Earth
CRAIG · CONDRY · HILL

▪

The Earth Then and Now
CRAIG · JOHNSON · LEWIS

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The Earth and Life Upon It

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THIS book is about the earth and the things that live upon it. That is why it is called *The Earth and Life Upon It.*

The earth is full of hundreds of interesting things which men called scientists have studied for centuries. They have asked questions like these:

How old is the earth?
How did the earth look when it was young?
What is inside the earth?
How far does the air go out into space?
How high are the clouds?
Where does energy come from?

You may want to know the answers to some of the many questions the scientists have been asking. This book has stories in it which answer many of the questions which you may be wondering about, too. It may help you to explain how things happen. Scientists are always trying to find out more about the things that happen. They watch, they experiment, they discover new things about the earth and the things that live upon it.

As you study this book you will want to watch, and experiment, and discover, just as the scientists do. You will in this way learn much about the earth, which is your home.

I

The Earth

THE SIZE OF THE EARTH

THE EARTH AND WEIGHT

WHAT THE EARTH IS LIKE

THE MATTER UPON THE EARTH

DID you ever stop to think what the earth is like? Have you ever wondered why the earth does not bump into the moon and stars?

Have you ever read about what the inside of the earth is like?

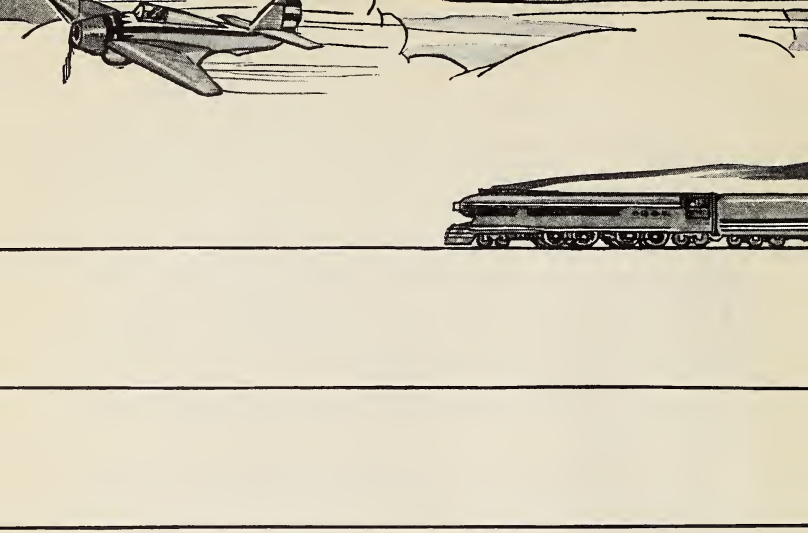
Do you know that the earth is really made of solids, liquids, and gases?

Do you know that land, air, and water are the three parts of the earth?

You must have many questions to ask about the earth.

You may find the answers to most of your questions by reading the stories about the earth in this book.

THE PICTURE ON PAGE 9 IS FROM A PAINTING BY BEN STAHL.



Make believe that each road in this picture is one hundred miles long. An airplane can fly one hundred miles easily in an hour. Trains do not travel so fast. A car is slower than a train. What about the other two travelers?

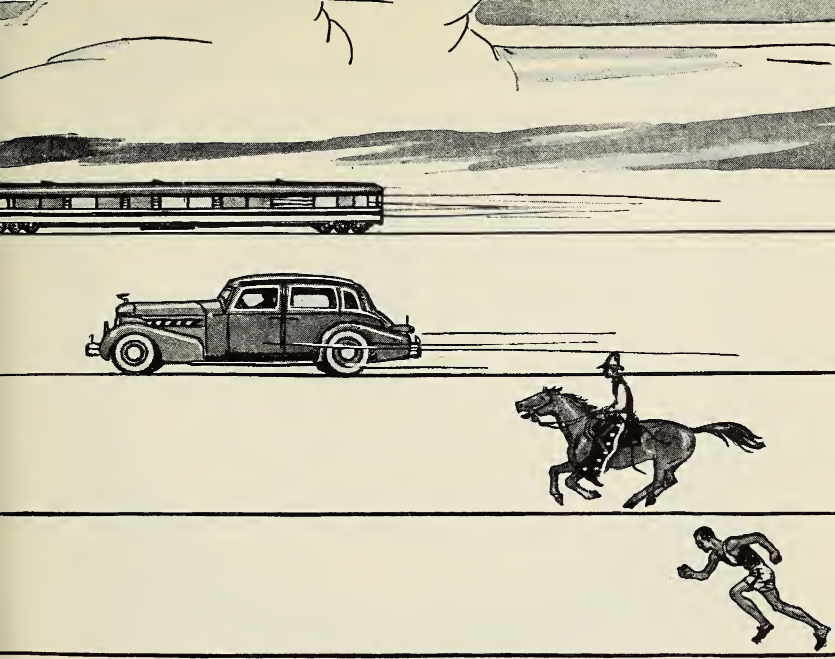
The Size of the Earth

THE EARTH IS LARGE AND SMALL

The earth is one of nine planets, or bodies, that move around the sun. We are more interested in the earth than in other planets, because the earth is our home.

The earth is round, like an orange. If you could cut the earth into halves and measure each half, you would find that it is 8000 miles through. What a long tape measure you would need! This distance through the center of the earth is called the diameter.

Now let us find out how far it is around the earth at the equator. You would need a tape measure, or rule,



a little more than three times as long as the one you used in measuring the diameter. Your tape measure would tell you that the distance, or how far it is, around the earth at the equator is 25,000 miles. The equator is halfway between the north pole and the south pole.

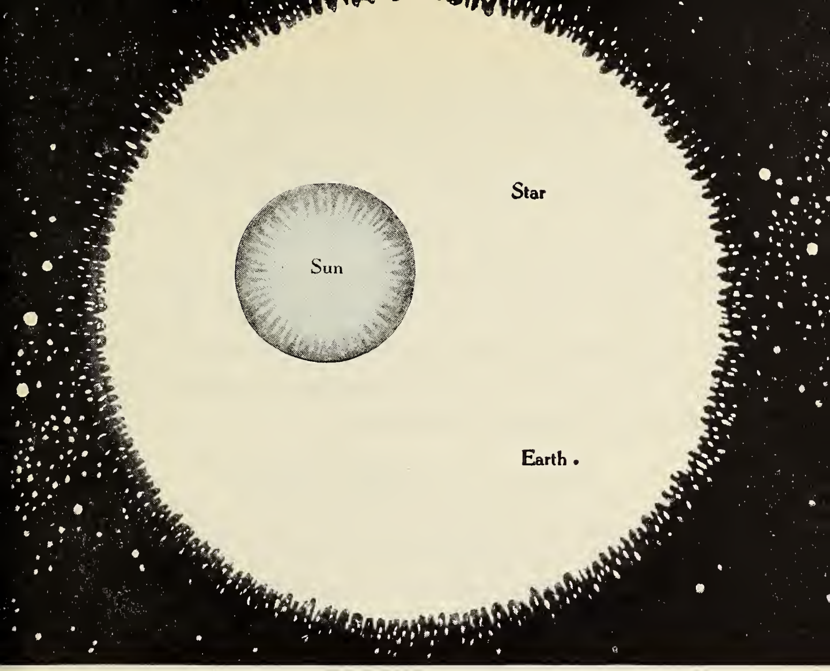
It is hard for us to get much of an idea about how far 25,000 miles is. Perhaps it will help if you think about how far you travel in automobiles. Those of us who have driven across the United States from coast to coast traveled about 3000 miles. If you were to travel across the United States and back four times, you would have gone about the distance around the earth.

Most of us think that a hundred miles is quite a long way. It takes about three hours to travel so far by automobile. It takes about two hours to go so far by train. It takes only an hour or less to fly a hundred miles. If you were to travel around the earth, you would have to travel many hundreds of miles.

Years ago, the earth must have seemed bigger to man than it does today. People traveled so slowly then. It took the Indians several days to walk a hundred miles. It took a farmer even longer to travel so far with his team of oxen. When mail was first carried by riders on horseback, a hundred-mile trip took about ten hours. Everyone thought that was very fast. The first trains would have taken eight hours to travel one hundred miles. Of course there were no automobiles or airplanes in the days of the first railroads. People traveled on foot, by horseback, by sailing ship, or by train. There were not nearly so many people traveling then as there are today.

Even though the earth must have seemed larger to people in days gone by than it does to us, we know that it really was not any larger. It is only because we can travel so much faster that our earth seems smaller now. But as we study more about the earth, we come to know more and more how very, very large our earth really is.

So large and yet so small! You have often heard this old saying. But did you ever think of the earth in this way? Yet this old saying fits the earth very well.



The earth is only a baby in size when we compare it with the sun and other stars. It would take a million earths to make one sun

Men who study the stars and planets tell us that the earth is only a baby compared with the size of many bodies in the sky. Let us compare it with the sun. It would take a million earths to make one sun. The diameter of the sun is about one hundred and nine times the diameter of the earth.

Suppose you think of the sun as a large basketball. Then think of the earth as a small pea. This will give you some idea of the difference between the size of the earth and that of the sun.

Now there are millions of other stars besides the sun in the sky. Some of these stars are many times larger than the sun. The sun is only a middle-sized star. It looks larger than all other stars because it is so very much nearer to the earth than they are.

Perhaps 93,000,000 miles does not seem near to you. That is the distance between the sun and the earth. But the sun is very much nearer to you than any of the other stars in the sky. The next nearest star is many thousands of times farther away.

THINGS TO THINK ABOUT

1. The earth is both large and small. It is large compared with your state. It is large compared with the United States. It is large compared with North America. It is large compared with the moon.

2. Yet, when we compare it with such objects as the sun and other stars, it is small. Our sun is a million times larger than the earth. Most stars are giants compared with our earth. Some of the planets are many times larger than our earth.

THINGS TO DO

1. Read to find out the fastest trips of airplanes and trains and steamships. What is the fastest trip by plane across the United States? What ship crossed the Atlantic in the shortest time?

2. Collect pictures showing ways man travels. Try to get pictures which show differences in travel now and long ago.

3. Make a clay model of the earth. Make another clay model of the sun. The distance through the sun model is over a hundred times larger than the distance through the earth model.

The Earth and Weight

THE EARTH IS A GREAT PULLER

What a queer world this would be

If apples fell from the tree *up* into the air instead of *down* to the ground.

If your ball did not come *down* to earth after you had thrown it *up* into the air.

If you could jump over a house as easily as you can jump over a pile of blocks.

If you could fall from the roof of a high building so slowly that you would not hurt yourself.

If water should spill *up* toward the ceiling instead of *down* toward the floor.

The earth is able to pull things to it. It pulls all kinds of things. It pulls everything about it. All of us are being pulled by the earth at this very moment. The earth pulls water, plants, air, boys, girls, dogs, and other things all the time.

This great pull, or force, of the earth is called gravity. No one knows just what gravity is. We know how it works. We know that it is the force which brings your ball down when you throw it into the air. We know that it is the force which brings rain, snow, and hail down from the clouds. We know that it is the force which makes an apple fall down instead of up when it leaves the tree.

The force of gravity does many other things. It keeps the water from spilling out of oceans. It keeps the air from leaving the earth. It holds the soil and rocks to the earth. It holds houses, cars, and people to the ground. Gravity even holds the earth together.

SOME OBJECTS WEIGH MORE THAN OTHER OBJECTS

Some children in a fourth grade were getting weighed. Jack weighed sixty-six pounds. Betty weighed fifty-four pounds. The children asked their teacher why Jack weighed more than Betty. Miss Bell, their teacher, told them that gravity is the force which gives things weight.

She said: "Things which can be seen or touched are called objects. Gravity affects all objects. It gives them weight. All of you are objects. Each of you weighs something. If Jack weighs sixty-six pounds, it means that gravity is pulling Jack's body down with a pull equal to sixty-six pounds.

"Now Betty weighs only fifty-four pounds. Gravity is pulling Betty's body down with a pull equal to only fifty-four pounds."

When your class gets weighed, someone may weigh seventy-two pounds. In that case gravity is pulling with a pull equal to seventy-two pounds.

You might try weighing other objects in your classroom. See how much each object weighs. All things do not weigh the same. Each object has its own weight.

You are not so heavy as your father because gravity does not pull so hard upon you as it does upon him.

Some objects are light in weight. Other objects are heavy. Two objects of the same size may not weigh alike.

Your rubber ball weighs less than an iron ball of the same size. Your magnet weighs more than a piece of wood of the same size.

If you could take all these objects you have been weighing and go to the moon, they would not weigh the same there. The force of gravity on the earth is

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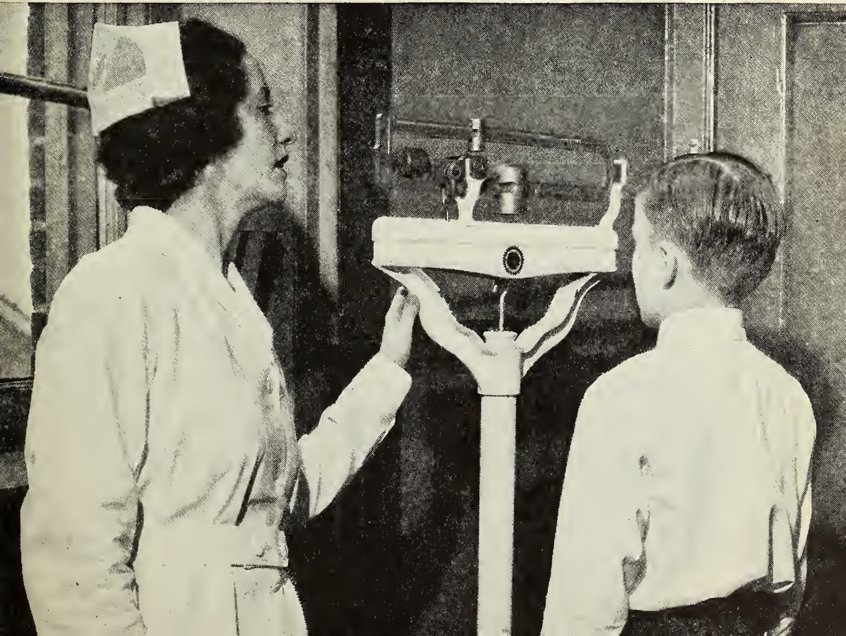
The school nurse is weighing Jack. He weighs sixty-six pounds.
How does gravity help to weigh Jack?

Galloway



six times as great as that on the moon. Jack, who weighed sixty-six pounds on the earth, would weigh only eleven pounds on the moon scales. Betty, who weighed fifty-four pounds on the earth scales, would weigh only nine pounds on the moon scales.

While you were on the moon, if you could really go there, you might like to try jumping. You would feel very light there and find it easy to make high jumps. Suppose that your score at school reads:

John Brown--three-foot high jump

If you tried jumping on the moon, you could jump six times as high. Your record would be quite improved. It would read:

John Brown--eighteen-foot high jump

Just imagine a "Moon Olympic Games" meet. All the famous earth runners and jumpers would surprise us with good moon scores. They would be six times better in the "Moon Olympics." And all because the force of gravity on the earth is different from that on the moon.

Now suppose that there could be a "Sun Olympic Games." You know, of course, that there could not be. But just suppose there could be. All who entered the contests would be very, very heavy. They could not run so fast or jump so high. These "Sun Olympics" scores would not be so good as those of the "Earth Olympics." Your score might read:

John Brown --very clumsy--could not get feet off the ground

Of course there is no ground on the sun, as you know. The pull, or gravity, of the sun would make the difference in the records. It is so much greater than the force of gravity of the earth.

But now getting back to earth again. The force called gravity gives each object its weight. Everything weighs something. Even a feather has weight, though your scales may not show it. In order to weigh very light objects, we need scales like those which your corner druggist uses for weighing small amounts of medicine. Watch him the next time you go to his store.

SOME OBJECTS FLOAT AND SOME OBJECTS SINK

Here again gravity is at work. Let us see how. The children of the fourth grade experimented with a few objects to see which ones would float and which ones would sink.

They filled a large pan with water. They gathered several objects which they wished to use in their experiment. To experiment means to try something to see what happens. Below is a list of objects the children used:

corks
nails
small stones
small blocks of wood
two small tin boxes
lumps of sugar
floating toys
a penny
steel magnets
a sponge

The children gathered around the pan. They took turns dropping one object after the other into the water. Some of the objects floated. Some of them sank. The blocks of wood and the corks stayed on top of the water. The toy fish, frog, and turtle also floated.

Now the children tried pushing the objects down to the bottom of the pan. Every time they let go of a toy, it came up to the top again. They could not make any of these objects stay down. They *were* puzzled. Gravity was at work here. Each object which floated is lighter for its size than water. Gravity made the toys push down upon the water; but the water, being heavier, pushed back upon the toys. The water would not let these objects push it out of the way. So there was nothing else for them to do but to float on top of it.

Next the children dropped some heavier objects into the pan. The stone sank to the bottom. The steel magnet went down, too. The nails and the penny also sank. Another puzzler!

And gravity is the reason again. All these objects are heavier for their size than water. They pushed down upon the water harder than the water could push up on them, and so they pushed some of the water out of the way. That is why they all sank to the bottom.

But when the children experimented with the sponge, it acted strangely. At first it floated. Then it slowly sank.

"That's different from any of the others," said Betty. "It floated for a while and then it sank."

And so a sponge always does. The reason for this is that while the sponge is dry, its many holes are filled with air. When the sponge starts getting wet, the water pushes the air out of the holes and stays there instead. Now as the holes fill up with water, the sponge keeps getting heavier and heavier. As it gets heavier, it slowly sinks to the bottom of the pan.

Next the children tried a lump of sugar. It sank to the bottom. Then it became smaller and smaller. Finally it disappeared. And where did it go? It dis-

These children are having fun. They are seeing what objects float and what ones sink

Doris Day

solved in the water. It was not lost. It was still there as part of the water, but it could no longer be seen.

Then Jack experimented with the two tin boxes. He pounded the sides of one box together with a hammer. As soon as it was put into the water it sank. The other tin box floated. The box which sank was heavier for its size than water. The one which floated was lighter for its size than water.

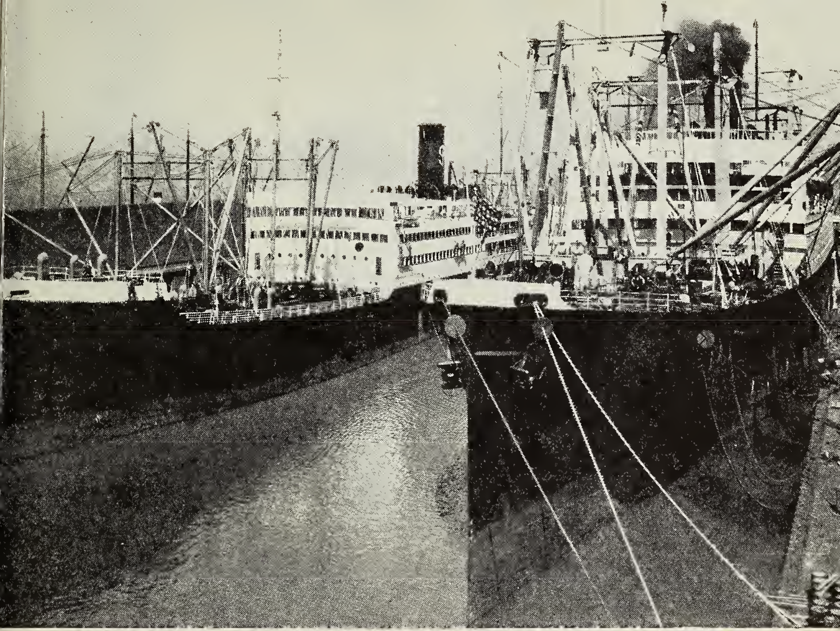
A big steel ship works the same way as the tin box which floated. Steel is really heavier than water, as you know. But when it is made into a big ship, the ship is so large that it is lighter for its size than water.

Perhaps you have seen a loaded ship. The water comes a good way up the sides of the ship. When the same boat is unloaded, it floats higher in the water. The load that the ship carries makes the difference. As the ship gets heavier, it floats lower in the water. If the boat carried too heavy a load, it would sink.

WHAT IS UP AND WHAT IS DOWN?

You have been learning that things always fall down. You have learned that gravity pulls objects down. Do you know just what *down* means? Do you know just what *up* means?

Suppose you should ask John, a boy living in North America, to point up. Which way would he point? Suppose you should ask Lopez, a boy in South America, to point up. Which way would he point? Suppose you



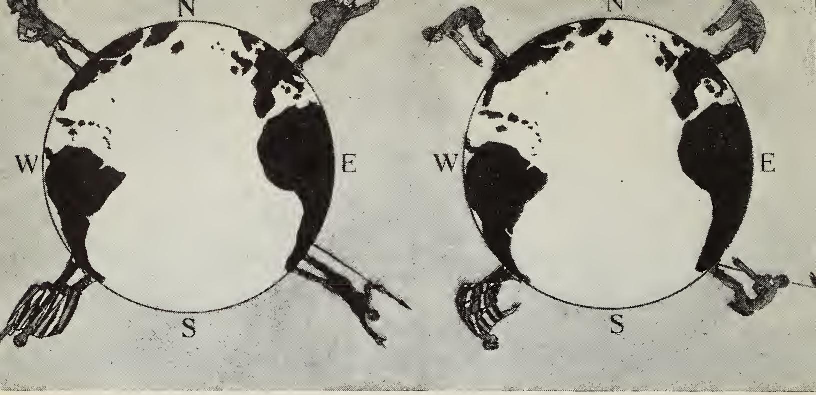
Galloway

One of these ships is loaded. The other is not.
Which ship floats higher out of the water?

should ask Ming, a boy living in China, to point up. Which way would he point? Or suppose you should ask Bomba, a boy in South Africa, to point up. Which way would he point? Would all these boys point the same way for up?

On the next page is a picture which shows the direction in which each would point. Each boy is pointing into the sky for up. All are pointing in different directions. Up is always away from the center of the earth.

Now suppose you should ask John, Lopez, Ming,



The boys in the left-hand picture are pointing up. Up is always away from the center of the earth. In the right-hand picture the boys are pointing down. Down is always toward the center of the earth

and Bomba to point down. Which way would they point? Would they point the way the children in the picture are pointing? Down is toward the center of the earth. It is the direction in which objects always fall.

The universe of which our earth is a part has no up and no down. There is no ceiling and no bottom to the universe. We never speak of up and down except when we are speaking of the earth. There is no up and down when we talk of the stars in the universe.

The stars are really all around our earth. They are on the day side as well as the night side of the earth. They are above the north pole and above the south pole of the earth. They are above the Atlantic and above the Pacific. Stars are above every part of the earth.

THINGS TO THINK ABOUT

Gravity is a great force. Suppose that it should stop working for a day. What might happen to the air, the clouds, houses, people, and the sea?

Gravity holds air to the earth. If this force were not present, there would be no life upon the earth. Animals and plants need air in order to live. Boys and girls need oxygen, one of the gases of the air, to make them strong and healthy. Many men who have studied about the moon say that it has no air at all, because it is too small for its force of gravity to hold the air to it. Larger bodies, like the earth, have a greater force of gravity than smaller bodies, like the moon. If there is no air on the moon, do you think there can be any life, as we know it, on that body?

THINGS TO DO

1. Take a stone in one hand and an eraser in the other. Stand on a chair. Drop them both at the same time. Which one reaches the floor first? Why did they fall down?

2. Ask your teacher to read to you about how a scientist named Galileo taught people about gravity.

3. Weigh yourself. From a table of weights find out whether you weigh enough for your height and age. If you do not, try to gain weight by following these health rules:

a. Eat plenty of cereals, fresh fruits, and green leafy vegetables.
b. Drink several glasses of water and milk every day.
c. Play outdoors at least four hours a day.
d. Sleep eleven hours each night in a well-ventilated room.
e. Rest for a few minutes after each meal.
f. Take a bath at least twice a week.
g. Brush your teeth at least twice a day.

What the Earth Is Like

PART OF THE EARTH IS SOLID

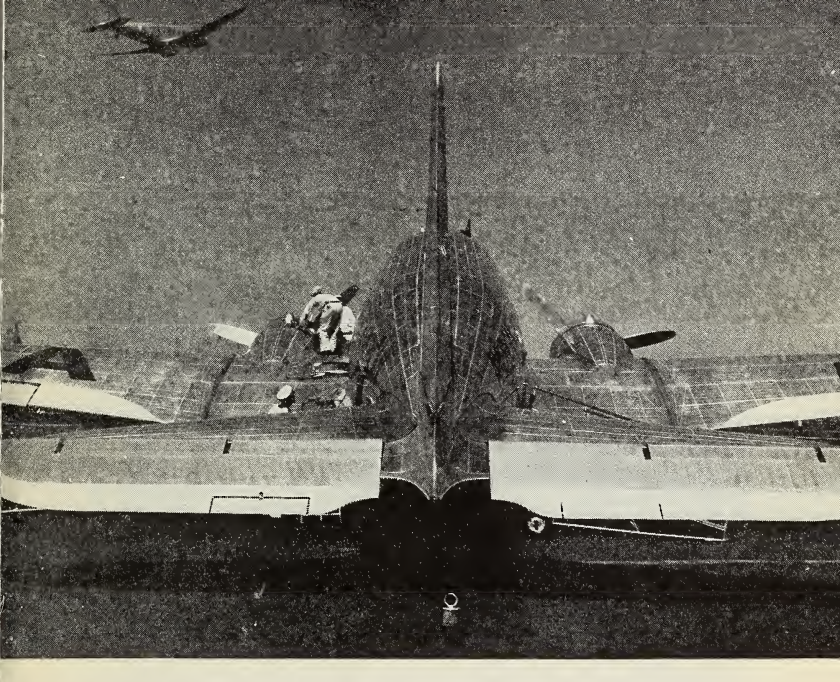
The earth has three parts. You know most about the land, or solid part, of the earth, because it is your home. Upon it your house, your church, your school are built. You raise your gardens upon it. You work and play upon the land part of the earth.

As far as we know, man has always lived on the land. He will probably keep right on living upon the land for ages to come. He will fly through the air and sail over the sea, but he will return to the land after each journey, and will spend most of his life upon it.

Long ago, men were afraid to go far from the land. Great tales were told of the dangers of the sea. Monsters and serpents waited to gobble up all who went far from shore. Columbus had a hard time getting his sailors to believe that such tales were not true.

You live at the surface of the solid part of the earth. You never leave this surface for long to go far above or below it. Men fly up a few miles, and dig down into the earth a few thousand feet, but most of us do our traveling right on, or very near, the earth's surface.

Although man can go but a very few miles away from the surface of the earth, he can study about places far away from the surface. Scientists have worked out ways of studying about these far-off places which man cannot visit.

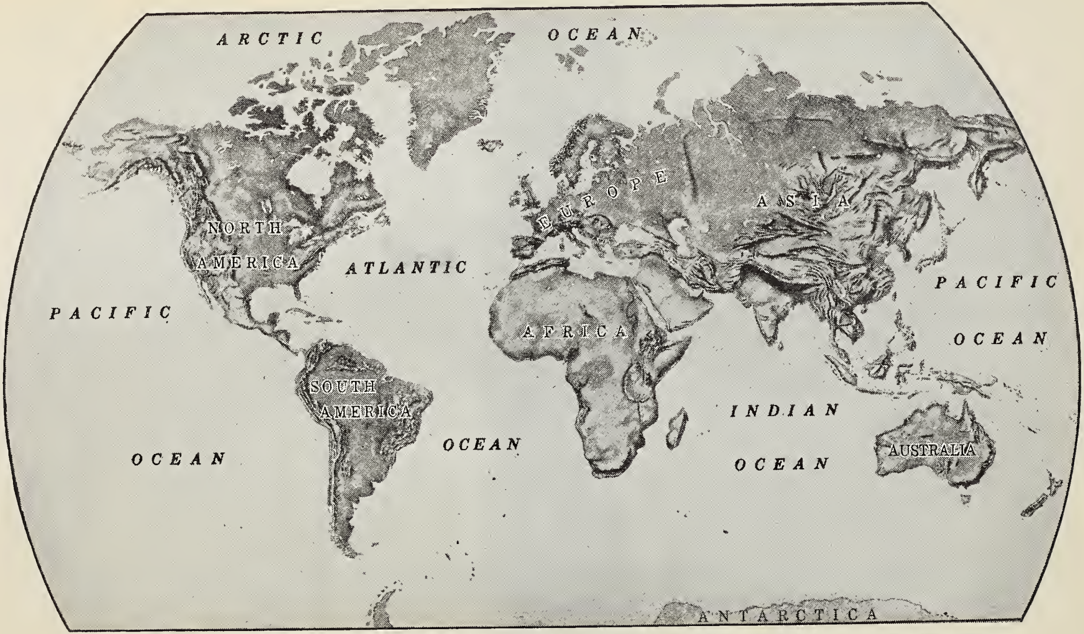


Great new airplanes like these take scientists up into the air so that they can learn more about the gaseous part of the earth

PART OF THE EARTH IS LIQUID

The liquid part of the earth is made up of water. You do not live upon it, but you use it in many ways. You travel upon it, and fish in it, and drink it. Even though you do not live upon it, you could not live without it.

Almost three fourths of the earth's surface is water. Look at your globe. Find the great bodies of water which cover so much of the land surface of the earth.



This map of the world shows you that there is much more water than land upon the earth

These great bodies of water are very important, because they help to make the land parts of the earth more comfortable places to live upon. Water warms and cools more slowly than land. In the summer, the land parts of the earth would be very much hotter than they are if the winds from the water parts did not cool them. In the winter, the land parts would become very much colder than they do if the winds from the water did not warm them. So you see it is very good for us that so much of the earth's surface is covered with water.

Water not only helps us to be comfortable, but it keeps us alive. All living things, both plants and animals, need water in order to live. You could go without food for quite a few days, but you could not do without water for so long a time. Some plants need more water than other plants. Some animals need more water than other animals. But there is no plant and no animal which can live without water.

You can really see only the surface of the water of oceans and lakes. They have filled in great valleys of the earth's surface. You would not find the bottom of the ocean smooth. It has great hills and deep valleys like those some of you see near your homes.

But even the oceans are not very deep. They do not reach far down toward the center of the earth. Men who have measured the oceans believe that the deepest parts are only about six miles.

Six miles may seem very deep to you. But if you think about the diameter of the earth, six miles is nothing at all. The oceans cover only the surface of the earth. They do not go down far toward the center of the earth.

The water of oceans, lakes, and rivers is not the only water upon the earth. Down beneath the surface of the earth there is water, too. Some of this water comes up to the surface as springs. Some of it shoots out as geysers. In some places the water flows along in rivers under the ground, and does not come to the surface of the earth. Much of the water gets into tiny holes in the rocks. It moves quite slowly.

PART OF THE EARTH IS MADE UP OF GASES

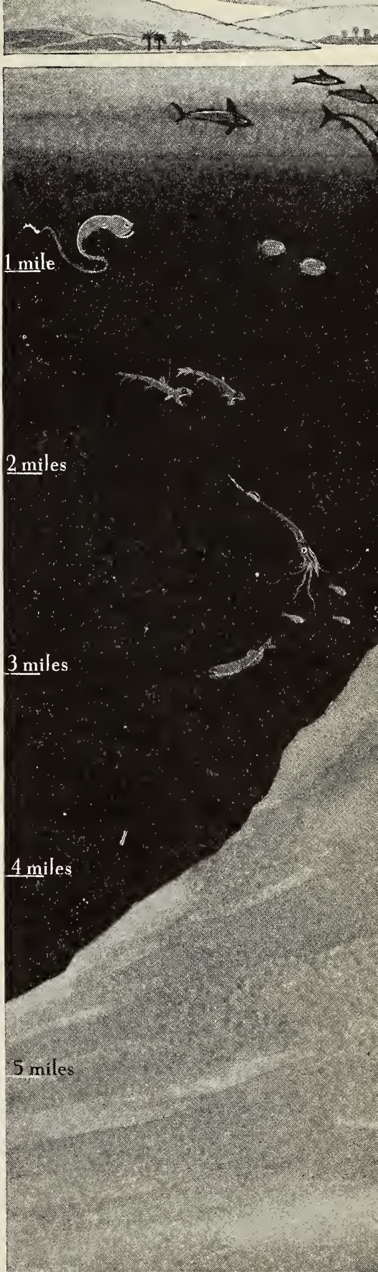
The third part of the earth is made up of gases. You do not live upon this part of the earth, but you use it. You could not live without it any more than you could live without the water part of the earth. All three parts are necessary for life. You live upon the land, and drink the water, and breathe the air.

The air is really the outside coat of the earth. It is made up of several gases. Although you cannot see them, you do breathe them.

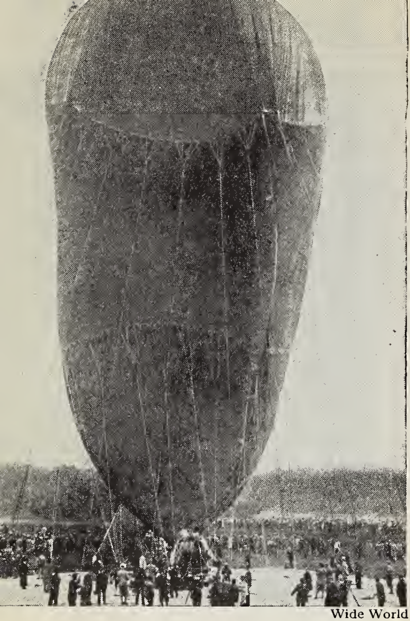
You live at the bottom of this ocean of air, which covers the surface of the earth. You are held to the surface by gravity. The air is held to the earth's surface by the same force. Scientists call this ocean of air, which we breathe, the atmosphere.

Gravity holds air everywhere about the earth's surface. It puts it through windows. Air fills all the little holes in the ground and in our bodies. Wherever there is a vacant space, gravity *pulls* air into it. So, really, air is everywhere around you. No matter how hard you might try, you could never get away from some air. For it fills all the cracks and corners around you. There is even air in water.

Men have often wondered in the past where the air stops. Even today no one knows exactly the answer to this question. We know the air is thicker and heavier near the surface of the earth. We know also that it goes up at least a hundred miles and probably more, getting thinner as it spreads out into space.



The bottom of the ocean is not smooth. It has great hills and deep valleys. The sea creatures do not live in the deepest parts of the ocean



Wide World

The bag of Professor Piccard's balloon is being filled with gas before the flight

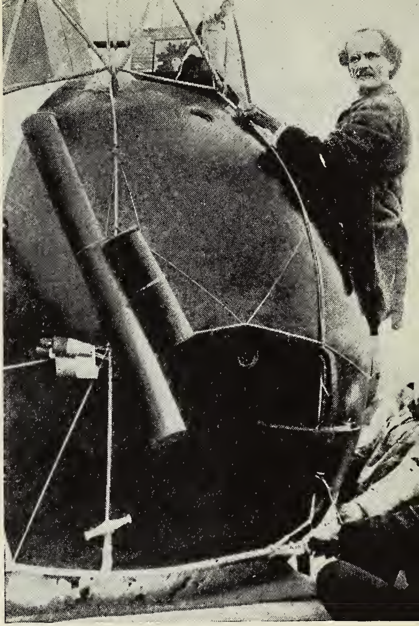
Scientists are learning more about the atmosphere all the time. Airplanes and balloons help in this work. Men have flown about eight and a half miles up into the air in airplanes. Aviators found the air so thin at that height that they had to wear oxygen helmets, which covered their noses and mouths.

Within the last few years there has been great interest in the balloon flights of scientists, and a number of things have been discovered about the atmosphere.

A Belgian scientist, named Piccard, was the first man to try such a flight to study the upper atmosphere. He planned a new kind of balloon. The bag was made of cloth, and filled with a gas called hydrogen. This gas was used because it is much lighter than air.

Professor Piccard and his helper shut themselves into the airtight gondola, or hollow aluminum ball. They wore oxygen helmets in order to breathe.

As soon as the balloon was set free, it rose into the air. Higher and higher it went. As it rose, the two men kept track of the temperature and pressure of the upper atmosphere. It became colder and colder. They put on heavier clothing. After seventeen hours, the balloon again reached the land. It had gone up ten miles into the air.


Wide World

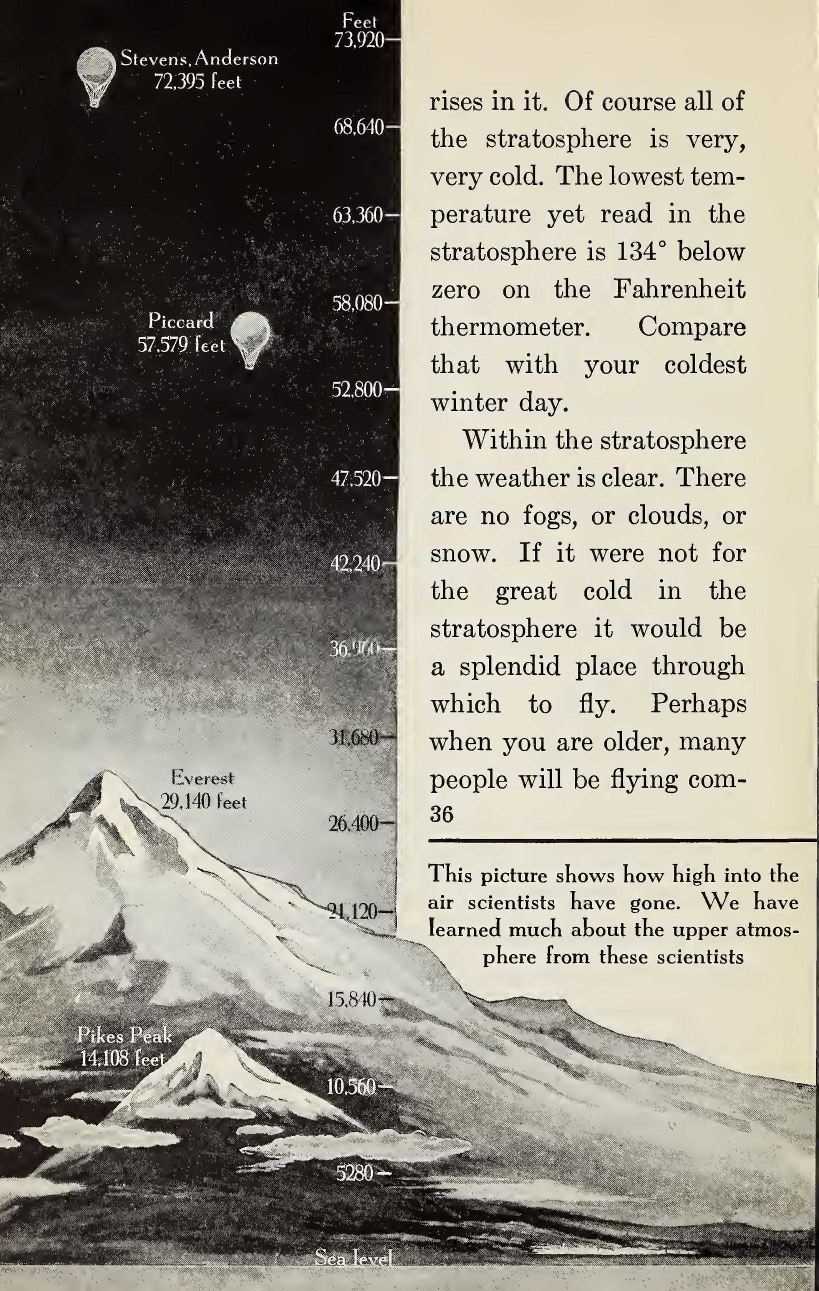
Professor Piccard making ready for his flight into the stratosphere

Other flyers have made such flights. Piccard reached a height of eleven miles on his second flight in 1932. It is thought that a Russian flyer got as high as fourteen and one half miles, but because of an accident the height is not known for sure. Two American flyers rose to a height of fourteen miles.

As a result of all these flights, we now know a great deal more about the gaseous part of the earth. We know that the atmosphere has layers, or parts. The first layer reaches from the surface of the earth up to a height of about six to ten miles. As an aviator rises in this layer, he notices the air becoming colder and colder.

The second layer, the stratosphere, goes up about thirty miles. Within the stratosphere the temperature stays the same. It does not keep getting colder as one rises in it. Of course all of the stratosphere is very, very cold. The lowest temperature yet read in the stratosphere is 134° below zero on the Fahrenheit thermometer. Compare that with your coldest winter day.

Within the stratosphere the weather is clear. There are no fogs, or clouds, or snow. If it were not for the great cold in the stratosphere it would be a splendid place through which to fly. Perhaps when you are older, many people will be flying com-



This picture shows how high into the air scientists have gone. We have learned much about the upper atmosphere from these scientists fortably through it. You may have a ride through it someday.

You can now see why we say that you live at the bottom of an ocean of air. It goes up over your heads for hundreds of miles and gets thinner and thinner as it spreads out. It is over boys and girls in Canada, China, Africa, South America, and every other country. These boys and girls are like fish in a lake. Fish have water all around them. Boys and girls are surrounded by air.

Suppose you compare the atmosphere of the earth to the peel of an apple. The atmosphere is the outer coat, or peel, of the earth. The peel is the outer coat of the apple. It goes all around the apple, and the atmosphere goes all around the solid part of the earth.

CLOUDS ARE IN THE ATMOSPHERE

The clouds you see in the sky are in the earth's atmosphere. They often seem to be far away. But the clouds you see are really very near the surface of the earth. They are not often more than six or seven miles above the solid part of the earth and are often within a mile or two above us. Sometimes clouds form right at the surface of the earth. We call these clouds fog.

Clouds are made of tiny droplets of water. These droplets of water were once just water vapor in the air. Water vapor is a gas. It cannot be seen. As the air cools, some of the water vapor turns to droplets of water. These droplets form clouds.

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Clouds often come so near the surface of the earth that they hide the tops of tall buildings

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The air is always either getting cooler or warmer. It does not keep the same temperature long. So clouds are always being made or changed. On some days there are many clouds to be seen. On other days there are few.

Clouds are not all alike. When the air is cool and the sun shines brightly, you see one kind of cloud. On dark, rainy days you see another kind. And on hot, bright days there are still other clouds in the sky.

You must have seen these different kinds. On a dark rainy day you see low, heavy, dark clouds. They just spread out over the sky and shut out some of the sunlight.

Then there are the sheetlike clouds which are seen on gray, cloudy days. It is likely to rain or snow when the sky is full of such clouds.

On bright, sunny, summer days, about noon, the sky may be full of white clouds. They look like the white of an egg after mother has beaten it, and often pile up in the shape of sheep's wool or round-topped castles. If these clouds turn black at the bottom, then watch out for a thunderstorm.

We can see the top of the mountains above the clouds

United States Weather Bureau

United States Navy official photograph

These clouds pile up like sheep's wool

On clear days you will often see thin, white clouds above you. They are quite high in the sky and trail off in long, thin tails. These clouds often form at the end of a fair-weather spell. Storms often follow such clouds.

Aviators watch the clouds. The gray clouds make it difficult to land a plane, because they are so near to the ground. Aviators cannot land so safely when the clouds are low. They listen to their radios to get weather news for flying.

Clouds are so near the earth at times that you may be above them. If you are on top of a high building or a high hill, clouds will sometimes be between you and the ground. If you have driven through hilly country, you have often seen clouds in the valley below you.

Even though clouds sometimes look as though they were almost out to the moon, they really never are. They are within a few miles of the earth. The moon is very much farther away.

THE INSIDE OF THE EARTH

The inside of the earth is as much a mystery to scientists as the atmosphere is. No one has ever dug farther down into it than a mile. Our deepest mines

Clouds like these are high in the sky. They trail off in long thin tails. They are often followed by storms

Mount Wilson Observatory

are only a mile deep. Some oil wells are deeper than mines. Rock samples have been brought up from these wells and studied. Scientists have to study the inside of the earth further from what few facts they know.

Strange stories have been told about what is under the earth's surface. For many years men thought that there must be a huge fire, like a big flaming bonfire, inside the earth. You can easily see how they happened to believe that. They saw hot rocks and ashes and clouds that looked like smoke come from some mountains. They saw hot water shoot out of the earth. It was natural for them to think that there was a fire inside the earth.

Some folks thought that the earth was like a huge pie. The outside, they believed, was like the crust of the pie. They lived in fear that some day the crust would break and that their homes would be destroyed by fire from within the earth.

These strange, untrue stories were believed by many. We now know that the inside of the earth is not hollow and that there is no fire there. Most scientists think that the inside of the earth is rigid, or firm, and that there is no danger that the earth will cave in.

The earth is heavy. The outside parts of the earth press against the inside of the earth. The inside parts press against each other. This makes great pressure inside the earth. This pressure causes heat. The heat is sometimes great enough to melt rock inside the earth. Sometimes a lot of gas and melted rock bursts

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Lava from volcanoes has flowed out of these mountains
and covered the land around

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through the surface of the earth. We call such places volcanoes.

Some volcanoes pour out lava, or melted rock, quietly. These volcanoes have broad low lava cones, or mouths. Other volcanoes shoot out lava and hot gases and ashes. We then say the volcano has exploded. The cones of these volcanoes are steep and high.

THINGS TO THINK ABOUT

1. Each of the parts of the earth is useful to you. The solid part is your home. You use the water for drinking, for fishing, and for swimming. The oxygen in the atmosphere keeps you alive. You could not live without these three parts of the earth.

2. Scientists are always discovering new things about the atmosphere. Many scientists are working to make it possible to fly through the stratosphere. Perhaps someday you will be able to do it because of their study.

3. If you watch the clouds, you will be able to learn more about the weather. You can have fun checking your own guess with the weather report in your morning newspaper.

THINGS TO DO

Fill the blanks in the sentences below with the words that will make the statements true. (*Do not write in the book.*)

1. The earth has ---?--- parts.

2. The land part of the earth gives us our ---?---.

3. Man has flown only about ---?--- miles into the air.

4. Men have dug only about ---?--- mile down into the earth.

5. There is ---?--- times as much water as land on the earth's surface.

6. The earth's blanket is the ---?---.

7. ---?--- holds the air to the land.

8. Clouds are in the ---?--- part of the earth.

The Matter upon the Earth

CHANGING SOLIDS, LIQUIDS, AND GASES

Everything upon the earth and inside the earth is either a solid, a liquid, or a gas. Wood is a solid. Water is a liquid. Air is a mixture of gases. All these things are called matter. Some children at school learned a great deal about these three parts of the earth by experimenting. Here is the story of their work:

Betty and Jack had heard about people called scientists. They knew that scientists could change the color, size, or shape, of many things by working with them. They knew that scientists had discovered many things about the earth which might not have been known if it had not been for their studying about them.

Jack and Betty wanted to do some experimenting. They decided to ask Miss Bell to help them.

"Oh, Miss Bell," said Betty and Jack in one breath, as they both pushed through the door of the schoolhouse, "we have the best idea for something to do. Will you help us?"

Miss Bell knew the children. When Jack and Betty got to thinking, something was always sure to happen.

Betty started to explain that they had decided to play they were scientists. Jack could not wait for his turn. He interrupted: "You see, Miss Bell, we have been reading about the parts of the earth. Isn't there some experiment we can do to learn more about them?"

Miss Bell needed no more time for thinking. "Do you know that sometimes the solid part of the earth changes to liquid, and that the liquid part of the earth changes to gas?"

"No, how?" asked several other children.

A table was cleared quickly. A couple of pans were brought from a cupboard. Miss Bell brought some canned heat and some matches. Now what was about to happen?

Miss Bell said, "I should like a solid for this experiment."

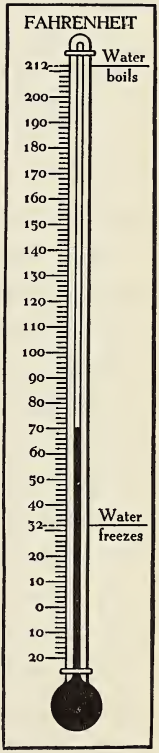
One child brought a pencil. Another a ribbon and another a book.

"I'm not going to use any of these things. They are all solids, but I want to start with another solid, if I may. Jack, will you run outside and bring in one of the big icicles which are hanging on the window?"

The children looked puzzled. Jack soon came back with the icicle.

"Where shall I put it? It's cold," he shouted.

"Put it in this pan," Betty suggested. "What are you going to do with this solid?"



The Fahrenheit thermometer is used a great deal. Can you find the boiling point and the freezing point of water on it?

The water in this teakettle is boiling. Some of it is turning to steam. You cannot see the steam. It is just at the mouth of the spout

"How do you think this solid can be changed?" asked Miss Bell.

A child near the table noticed that the ice was changing already. "I know," he shouted. "Heat it!"

No sooner had he said this than it was done. The canned heat was lighted and placed under the pan of ice. Slowly the ice disappeared. It melted to water.

"But, Miss Bell," said John, "the solid icicle changed its form and is now water. What made it do that?"

Someone said that ice melted when it became warm.

"How warm?" asked Miss Bell.

No one knew. So she told them that when the temperature gets to be 32° Fahrenheit, ice turns to water. "If the temperature goes below 32° Fahrenheit, then the water freezes into ice," added Miss Bell. "That is why your father, if he drives a car, has to watch the thermometer in the winter. He has to be sure that the water in the car radiator doesn't freeze."

"Oh," said Jack. "Once my father forgot to put alcohol in the radiator of our car, and the water froze to ice and burst the radiator."

"What does Fahrenheit mean?" asked John.

"Fahrenheit is the name of the scientist who made one of the thermometers which we use a great deal," answered Miss Bell.

Betty interrupted to ask, "But, Miss Bell, you can't change water into anything but ice, can you?"

"That's just what I was about to show you," said Miss Bell. "Let's heat the water from the icicle and see what happens."

Miss Bell boiled the water in a teakettle. She asked the children to point to the steam. Mary pointed to the small cloud that seemed to come from the kettle.

"No," said Miss Bell, "that is not steam. You cannot see steam."

"Oh," said John, "the steam is next to the spout where you can't see anything."

John was right. Steam is invisible; that is, it cannot be seen. The cloud was made up of droplets of water, where the steam, or gaseous part, had changed back into water. Watch water boiling. The steam will be just above the water.

You know that the water has to be very hot before it turns to steam. Water boils at 212° F. (Fahrenheit). Steam is very hot, too. You would get burned if you put your hand in the steam.

Perhaps you would like to find out what the temperature of the steam is. Use a thermometer which will measure 212° F. Hold the thermometer in the steam. What does it read? Is the steam as hot as the water?

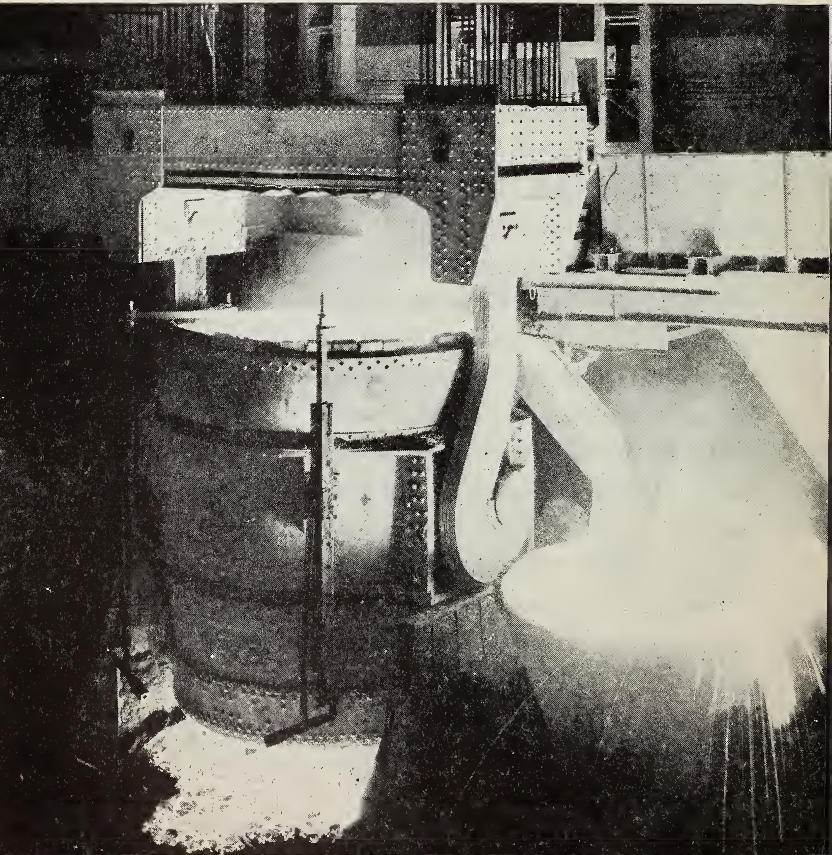
You may find that the thermometer is moist when you pull it out of the steam. That is because part of the steam is condensing back into water again.

Be sure you do not put an ordinary thermometer into steam, because it will break if you do. Ordinary thermometers do not read as high as 212° F.

The children wanted to know more about changing

When iron is heated very, very hot, it melts

Richie



solids to liquids, and liquids to gases. Miss Bell told them that when solid iron was heated to a very high temperature, it melted and turned to liquid.

Every child in Miss Bell's room was glad Jack and Betty had got their heads together. They had enjoyed doing experiments so much that they wanted to do other things at school which would help them to understand science better. Miss Bell told them that on another day she would show them more about the differences between solids, liquids, and gases.

They had learned several new science words while they experimented. They now knew that solids melt; that is, that solids turn into liquids. They now knew that liquids turn into gas. They now knew that water vapor condenses; that is, that water vapor turns back into tiny drops of water. They also knew that liquids freeze, or turn into solids.

DIFFERENCES BETWEEN SOLIDS, LIQUIDS, AND GASES

A few days later Miss Bell went on with the work about solids, liquids, and gases. The children wanted to know how these three things were different.

"Is your desk a liquid?" asked Miss Bell. The children laughed. They knew that their desks were solids. Miss Bell wanted to know how they knew desks were solids.

"Because they keep their shapes," Alice said.

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OF ALBERTA

"Because they are hard," added Betty.

"Because they stay where they are put," said Jack.

"Alice is right," said Miss Bell. "Solids do keep their shape. Did you ever see a desk go flowing around the room? But Betty is not right. Cotton is solid, and blankets are solids, but they are both soft. Jack, your answer was right. Solids do stay where they are put. They do not flow about."

"What about liquids?" asked Jack.

"I know," said Betty. "Solids keep their shape. Liquids don't. They flow about. They go into every hole or opening they find in the solid parts of the earth."

"Liquids have no shape of their own," said Miss Bell. "The sea water takes the shape of the bottom of the ocean. The water in a pail takes the shape of the pail. Liquids take the shape of the pan, pond, lake, ocean, or whatever else they are in."

"Liquids are kept on the earth because of gravity," said Miss Bell. "If it were not for the pull of gravity, liquids would flow right off the earth."

"What about gases?" asked Betty. "How are they different?"

"We live in an atmosphere made up of gases," said Miss Bell. "The gases we breathe are called air. Does air flow about, or does it keep its shape?"

"Air flows about," said Betty. "It goes into any hole or opening in the solid part of the earth."

"That's right," answered Miss Bell. "But gases spread out more than liquids. They try to fill all the space there is. Gases stay near the earth because of gravity's pull. The air would probably wander away from the earth if gravity were not strong enough to hold it."

Miss Bell wrote the following questions on the board for the children to answer. Betty and Jack answered all of them.

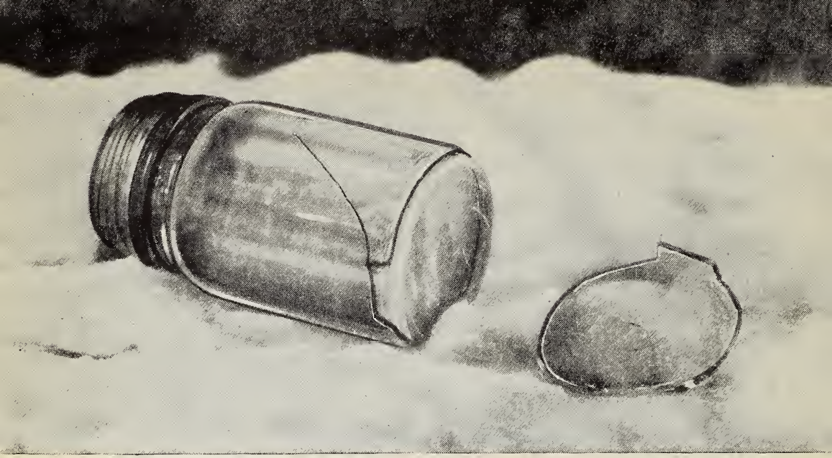
See how many you can answer.

1. Can you walk *on* water?
2. Can you walk around *in* a solid?
3. Can you walk *through* the air?
4. Can you sit down *on* water?
5. Does a solid keep its shape?
6. Does a liquid keep its shape?
7. How is a solid different from a liquid?
8. How is a liquid different from a gas?

WHAT HAPPENS WHEN WATER FREEZES

Another day the children in Miss Bell's room were doing an experiment. They wanted to see what happens when water freezes. They filled a glass jar full of water right up to the very top. Then they placed the cover on tightly and set the jar in a snowbank, where it would be cold.

They came to school early the next morning. They found the water frozen and the jar broken. Miss Bell told them that when water turns to a solid it needs more room than when it is a liquid. There was no



The children found their glass jar broken. The water inside the jar had frozen. There was not enough room for the ice; so the jar broke

more room in the jar; so the ice had to break it to make room for itself.

"Now I see why dad's radiator burst when the water froze in it last winter," said John. "The ice needed more room; so it burst the pipes."

"Have you ever seen cracks and bumps in the sidewalks in the spring of the year?" asked Miss Bell. "These were made because the water under the sidewalks froze and needed more room. It cracked the sidewalks or made them hump up.

"The same thing happens in rocks. Water runs under them, between them, and into their cracks. When it gets cold, this water freezes. When water freezes, it expands, or spreads out. The rocks have to break to make room for the ice."

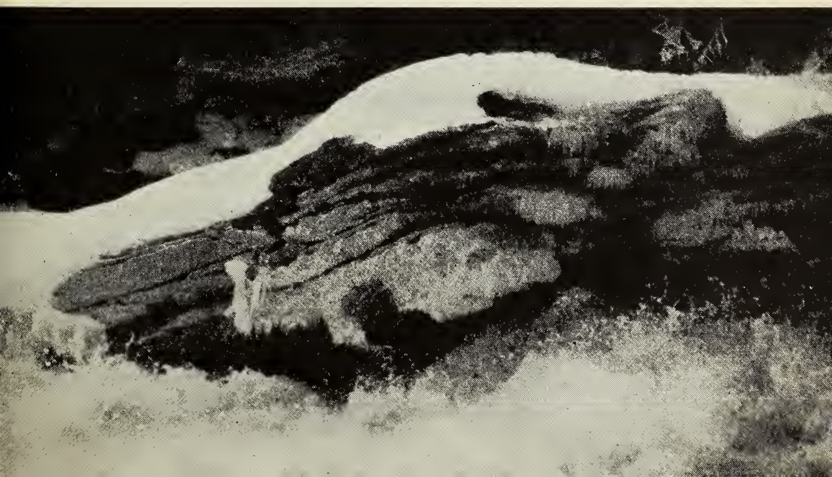
You may want to try an experiment at home. Perhaps you have no snow or freezing weather where you live. Then try this:

Fill a small bottle with water. Place the top on tightly. Put it in the freezing drawer of your refrigerator. If the temperature is below 32° F., the water will freeze and crack the bottle.

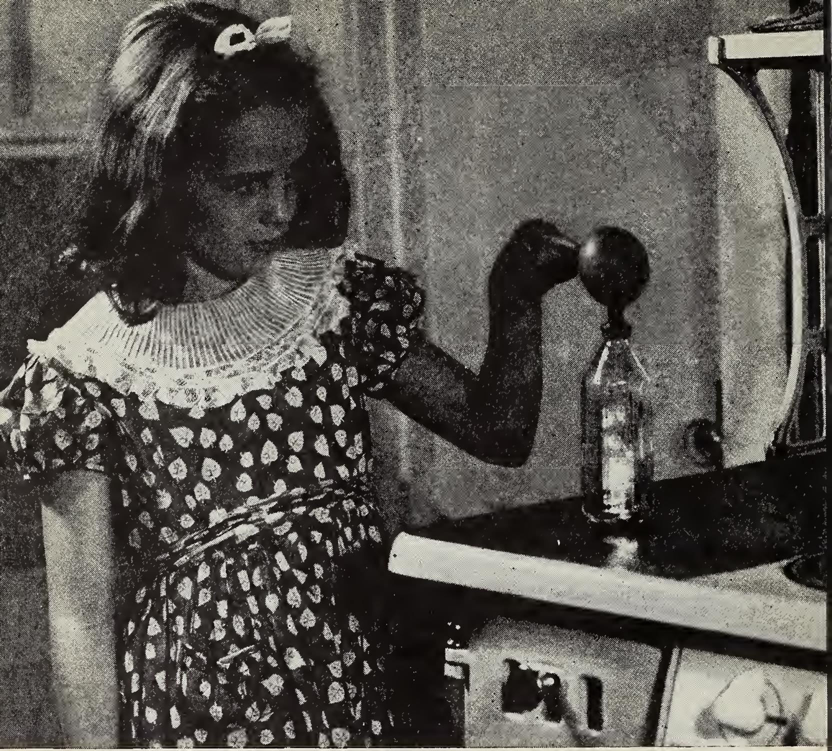
HOW HEAT AND COLD AFFECT SOME THINGS

Heat makes most matter expand, or get larger. Cold makes most matter contract, or get smaller. You can do an experiment to show that these two things are true.

Tie a rubber balloon over the mouth of a bottle that can be heated. A pyrex nursing bottle will do. Hold the bottle over heat. Soon you will see the balloon slowly



Water often freezes in the layers of rock.
It causes the rocks to crack as they have in this picture



Doris Day

As the air inside the bottle becomes warm it expands and makes the balloon get larger

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filling out. As the air inside the bottle becomes warm, it expands. It needs more room. So it spreads out into the balloon.

Now let the bottle cool. You will see the balloon getting smaller and smaller. The air inside is cooling. When air cools, it takes up less space. We say it contracts.

Metal does the same thing. It expands when it is heated. It contracts when it is cooled. Men who build bridges have to be careful to allow for this difference. They leave small spaces between parts of the bridge, so that the steel will have room to expand on very hot days.

In New York City the swing bridges over the Harlem River have caused trouble on very hot days. When they were swung open to let boats pass by, they could not be swung all the way back, because they were too big for the space. This does not happen often, because the bridge-builders leave space for the steel to expand. But it has happened on very, very hot days.

No doubt you have wondered why road-builders leave a crack in concrete pavement every few yards. They know that concrete expands as it gets hot and contracts as it cools. The spaces allow the concrete to expand without breaking and spoiling the road.

Sometimes your mother has a hard time opening a glass jar. She often puts the metal top of the jar into hot water. Then when she tries again, the top comes off easily. This is because the heat of the water has expanded the metal cover.

THINGS TO THINK ABOUT

1. Water has many uses, because it boils at a low temperature and freezes at a rather high temperature. Suppose it boiled at 500° F. and froze at 90° F. What difference would that make in our use of it?

California Toll Bridge Authority

The men who build large bridges like this one leave room for the steel to expand with the heat, and to contract with the cold

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2. What is the difference between a solid, a liquid, and a gas?

3. Give examples of what heat does to objects which you see about you.

THINGS TO DO

1. See how many things you can add to the list below.

Solids	*Liquids*	*Gases*
ice	water	steam
cloth	milk	oxygen

2. Put some water from the faucet into one pan. Put some water and alcohol into another pan. Place them on the window sill on a cold day. Hang a thermometer on the window. See how cold it is when the water freezes. Does the mixture of water and alcohol ever freeze in the other pan?

3. Here is something for you to try. It will help you to understand why dark woolen clothing is better for cold winter days than for hot summer days.

Put the same amount of water into two jars of the same size. Put a thermometer in each jar. Read each thermometer. Now put a piece of dark woolen cloth around one jar. Put a piece of light cotton cloth around the other jar. Set the jars in the sun and let them stay there for about thirty minutes.

Now find the temperature of the water in each jar. The water in which jar was heated more? Do you see why we wear light cotton clothes in the summer?

II

The Changing Earth

HOW THE EARTH MOVES

HOW OLD IS THE EARTH?

FORCES WHICH HAVE CHANGED THE EARTH

THE earth has not always looked the same as it does now. It is many, many years since the earth was young. During all these years many interesting things have happened to change the looks of this great spinning ball which keeps on turning about the sun.

High mountains have been worn away. Small islands have been covered up entirely by the sea. Smoking volcanoes have shot hot melted rock into the air, and earthquakes have cracked the earth's surface. Oceans have come over the land, and new land has been pushed up out of the sea. You may want to know something about how and why such queer things have happened to the earth. The next chapters will tell you about them.

THE PICTURE ON PAGE 63 IS FROM A PAINTING BY BEN STAHL.

How the Earth Moves

WHY WE DO NOT HAVE DAYLIGHT ALL THE TIME

What a queer world this would be if daytime should last all through the year! Do you think you could live in a world which never had any night? Do you ever wonder what causes day to follow night, and night to follow day, as it always does year after year?

The earth is always moving. It never stands still. It got started spinning a long time ago; and it never stops, because it cannot. There is nothing to stop it; so it keeps right on moving, or spinning, around.

You have often played at spinning a top. The earth spins around as a top does. Although the earth spins very fast, it takes a long time to turn all the way around. While the earth is turning around once, many things are happening to you. You go to bed once and you get up once. You eat breakfast, dinner, and supper. You go to school, and you come home from school. It takes the earth twenty-four hours to spin all the way around. We call twenty-four hours a day, but it is really a day and a night.

Scientists call this spinning of the earth rotation. They say the earth rotates once every twenty-four hours.

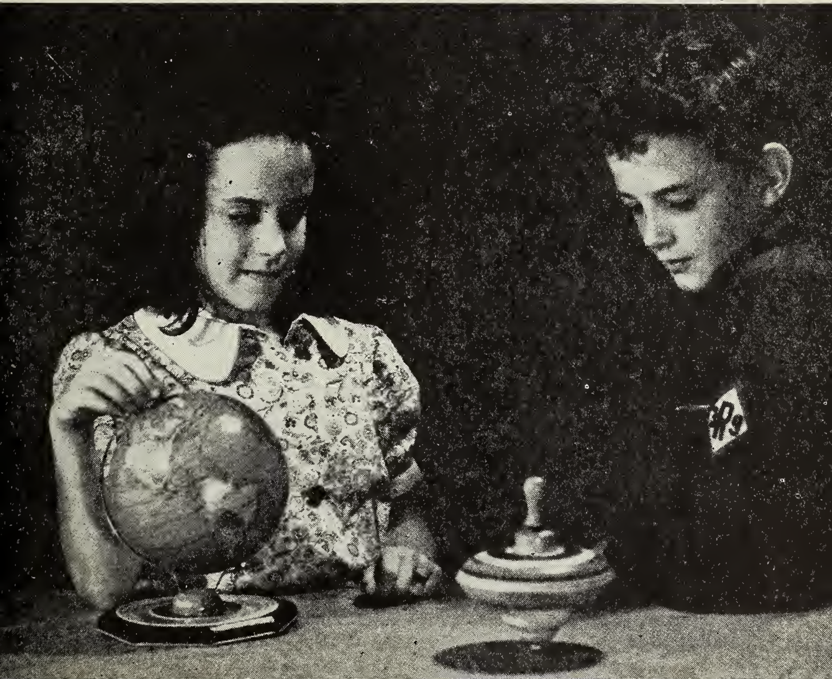
Now because the earth is round, we have day and night. Only half of the earth can be turned toward the sun at one time. Only half of the earth is receiving light.

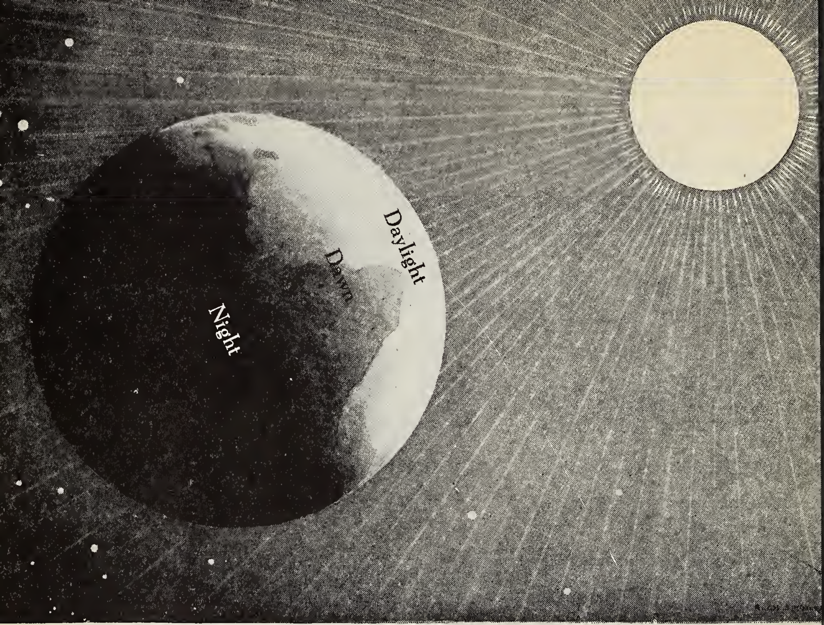
While your half of the earth is lighted by the sun, you are having day. Now many animals are looking for food. Plants are growing. Children are playing, and grown-up people are working. Factories are running with a busy hum. Houses and roads and bridges are being built. Your half of the world is very much alive.

But when your half of the earth is turned away from the sun, you have night. Then many animals are asleep, others are hunting for food. Trains are running and boats are traveling. But most people are asleep. A few policemen and night watchmen are on guard, and milkmen are delivering milk; but most people are at rest.

The earth spins around and around, somewhat as your top spins

Doris Day





Half of the earth has day while the other half is having night

Here is something to do to help you to understand the earth's rotation better. Follow these directions carefully. Place a globe on the table or the floor. A short distance from your globe place a lighted candle or a flashlight to represent the sun. Find the place on the globe where you live. Now turn the globe so that the lighted candle or the flashlight, which is the sun, comes up in the east and sets in the west for your town. Keep on rotating the globe. Be sure that you are rotating it in the opposite way from the way the hands of a clock move. The picture on page 68 will show you how to rotate the globe.

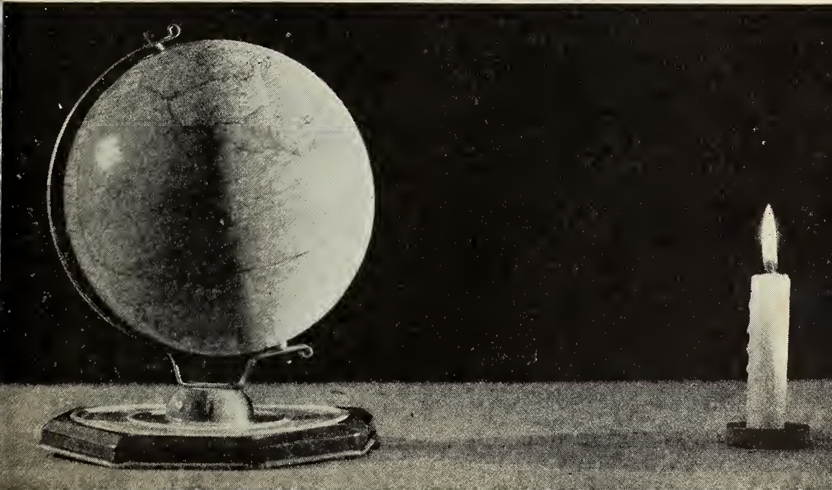
Notice as you rotate the globe that the light from the candle or flashlight falls only on the half of the globe which is facing it. This half is having day. The half of the globe which is turned away from the light is having night.

When it is morning where you live, your half of the earth is just turning toward the sun. Then you get heat and light. By night your half has rotated so far that it is turning away from the sun. Then you no longer receive heat and light from it.

Once each day the Chinese are turned toward the sun. Later, as the earth rotates, Russia faces the sun, and it has day. A few hours later England has light, because England is turned toward the sun. The light starts across the Atlantic Ocean. When it reaches North America, the people of the United States, Mexico, and Canada start to get up. A few hours later the Hawaiian

Only one half of the earth is lighted by the sun at one time

Doris Day



children wake up. When children in North America are getting up, the Chinese boys and girls are just going to bed. Do you know why?

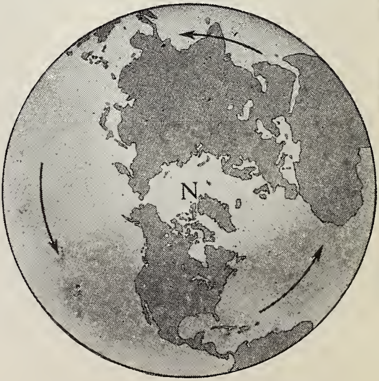
If you think about this, you will know that the earth rotates toward the east. New York City gets the rising sun three hours before San Francisco does. This means that New York City time is three hours ahead of San Francisco time. In order to have this happen, the earth must be rotating toward the east.

This difference in time is often noticed on the radio. If the President of the United States talks to the nation from Washington at 11 P.M. Washington time, this is a late hour for the people in the East, but it is only 8 P.M. on the Pacific Coast.

The Governor General of Canada would also have to consider this difference in time if he should speak on the radio to the Canadian people.

The hands of the clock move to the right.

The earth rotates in the opposite direction



When there is a football game beginning at 2 P.M. on the western coast, those people on the eastern coast who want to hear the game over the radio tune in at 5 P.M.

Perhaps you have listened to a radio program from London. If you heard this program at 5 P.M. in New

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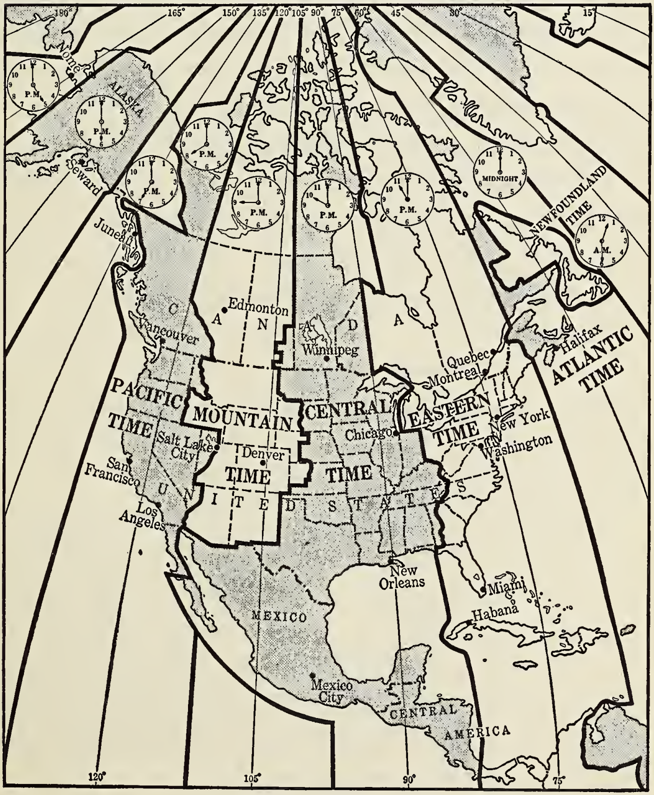
This map shows the time belts of North America



York, the people in London heard the same program at 10 P.M. Remember that London time is five hours ahead of New York time.

People who travel across North America notice this difference in time. Suppose they leave New York and travel west. When they reach Chicago their watches will have to be turned back an hour to be the same as Chicago time. As they travel farther west and reach Denver, they must turn their watches back another hour. And by the time they reach San Francisco, they must put their watches back still another hour.

When they are ready to travel back to New York, they will find that they must do tricks with their watches again. As they travel east, they will have to keep setting their watches ahead—first an hour at Denver, then an hour at Chicago, and again an hour at New York.

The same thing is true if you travel west from an eastern city in Canada. Suppose you journey west from Quebec. You will have to change your watch three different times before you reach the Pacific Ocean. Pacific time is three hours behind Quebec time.

You have to do the same thing with your watch when you cross the Atlantic Ocean. Suppose you sail from New York for England. At midnight the ship's clock is set ahead an hour. The reason for this is that your ship is traveling eastward and that you have to catch up with London time, which is five hours ahead of New York time. When the clock has been set ahead five hours, you will have English time.

On your return trip you have to do just the opposite. You have to set your watch back an hour at midnight, because New York time is five hours behind England's time. When you have turned your watch back five hours, you will again have New York time.

Many places in our country use daylight-saving time during the summer. They set their clocks ahead an hour in the spring, and back again an hour in the fall. Sometimes this mixes up travelers who are going about from place to place.

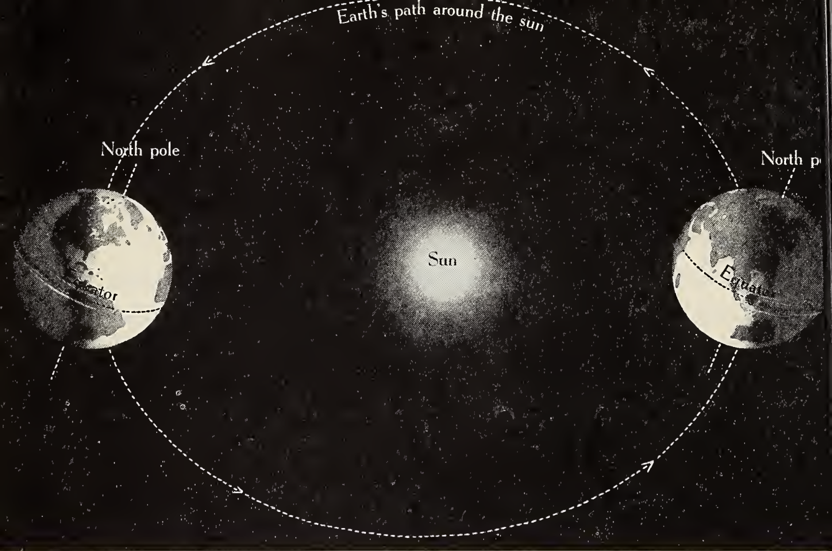
Daylight-saving time means just what it says. People wanted to use the long hours of late-afternoon daylight in the summertime; so, by setting the clocks ahead one hour, they saved an hour of daylight each evening. During this hour they could work in their gardens or on their farms, play golf or tennis, swim, or find other enjoyment.

THE EARTH MOVES AROUND THE SUN

While the earth rotates, it also goes around the sun. We say the earth revolves or goes around the sun.

Once every 365¼ days the earth makes one trip in its path around the sun.

The earth never gets very much nearer to or farther away from the sun as it goes around it. The earth's path is about 93,000,000 miles from the sun. Year after year the earth has been traveling in this path.



The earth revolves in a path around the sun.

Only half of it gets light from the sun at one time

THINGS TO THINK ABOUT

1. We could not live on an earth which always had daytime any more than we could live on an earth which always had nighttime. A daytime earth would become so hot and dry that no plants, people, or animals could stay alive. A nighttime earth would become so cold that nothing could live.

2. Night is needed to cool the earth after the heat of day. Day is needed to warm the earth after the coolness of night.

3. Perhaps you can think of some other reasons why we must have both day and night in order to live.

4. The distance around the earth is about 25,000 miles at the equator, and the earth turns around every twenty-four hours. Perhaps you would like to find out how many miles the earth at the equator turns every hour? Is that faster than a fast train travels?

5. As you look about you on the earth, it is hard for you to believe that you are on a ball moving so fast. There is no jar or shaking as there is on a train. There are no stop lights for the earth as there are for an automobile. There are no objects such as houses and telephone poles for the earth to pass as it moves.

THINGS TO DO

1. Divide North America into time belts on a map. Find out what time it is in a city of one time belt when it is nine o'clock in the morning in a city of another time belt. What time is it in Montreal when it is six o'clock in the evening in San Francisco?

2. Place your schoolroom globe so that a bright light can shine on the place where you live. Turn the globe around very slowly.

Can you see how the earth turns you away from the sun so that night comes to you?

Can you see how the earth turns you toward the sun so that day comes back to you?

How Old Is the Earth?

THE EARTH IS OLD

It was Jack's birthday. He told the children in his room that he was really old now. He was nine years old. Betty did not think he was old. She said he was still very young.

"Just think," she said, "how young you are compared with the age of the earth."

Miss Bell tried to help them out. In doing so she told them what scientists say about the age of the earth. She said: "No one knows just how old the earth is. We know only that it is very, very old. Let us try to understand what we mean when we say the earth is very old. Do we mean a hundred years? Do we mean a thousand years? Just what do we call old?"

"I know a man who is almost a hundred years old," said Betty. "He is a fine old gentleman. He has done many things in his long life. All his friends think of him as a very old man. I do, too."

"That's right," answered Miss Bell. "Very few people live to have a hundred birthdays. Yet when the earth was a hundred years old, so the scientists say, it was so young that no people lived upon it. There were no plants living upon it anywhere. On its hundredth birthday it was not at all as it is today."

"What was it like when it was a thousand years old?" asked Jack.

"A thousand years or more ago some brave sailors, called Vikings, are said to have crossed the Atlantic and reached the shores of North America," said Miss Bell. "When you read about these men in your history books you will think of them as coming to America a long time ago. A thousand years is a long time in a history book about people. But a thousand years, we are told, is only a moment in a history book about the earth."

"What was the earth like when it was a thousand thousand years old?" asked Betty.

"A thousand thousand means a million. Scientists say that when the earth was a million years old, it was still very, very young," answered Miss Bell. "They believe it had a few tiny lakes and rivers, perhaps, and some atmosphere, but no trees, no fish, no people."

"What! No people yet?" the children asked.

"My, no!" said Miss Bell. "We are told that the earth had millions and millions of birthdays before man came to live upon it and that hundreds of different kinds of animals had lived here before man came."

Miss Bell went on: "The first men to live upon the earth lived in trees and caves and made rude shelters. They used tools which were made of rough stones. They fished and hunted for their food

"It has taken more years than you could ever count for the earth to grow up. Who can say how old the earth is even today? No one can."

"I'm sure now that Jack is very young," said Betty.

Jack said nothing, because he knew Betty was right.

THE EARTH HAS CHANGED IN LOOKS MANY TIMES

Since no one was living at the time the earth was young, no one knows for sure just what it was like. Scientists believe that when the earth was young the crust, or outside, of the earth was a mass of rock. Part of the rocky crust was pushed up in places by forces within the earth, and so mountains were formed. The places between the mountains of rock were deep valleys.

For years and years and years the earth remained bare and rocky and lonely. It had no water. It had no air. It had no soil. As the earth grew older, it slowly gathered an atmosphere and water. Slowly air and water began to change the earth. Soil began to collect on the outside of the earth. After all these years tiny plants and animals formed. They were so small that they could not be seen. If man had been there, he would have had to use a microscope to see them.

As time went on, the plants and animals kept getting larger and larger. In fact, after another very long period of time some of them became huge in size. Great ferns and trees and huge animals called dinosaurs lived on the earth. Of course, not all the plants and animals of that time were very large. Some of them were, in fact, very small.

After yet another long time, man came to live upon the earth. He cut down trees. He worked the soil and planted and harvested his crops. He built homes and

© Field Museum of Natural History, From a painting by Charles R. Knight

A long, long time ago huge animals like these lived upon the earth schools and cities. He built dams to store up water to use later. He drained the swamp lands and planted more crops there. He built factories and tall buildings.

So it is that age after age the earth has slowly changed in looks. If we could have seen the earth when it was young and could compare it as it then was with the earth today, we should see many changes in it.

THINGS TO THINK ABOUT

1. To us a century, or hundred years, seems a long time. Very few people live a century. Yet as we think about our great earth, we know that it is very, very old, much older than a century. We know that it has changed its looks many times.

2. As you learn about the great changes which have taken place upon the earth, you may come to feel that the earth is the oldest object in the whole world, or universe. But this is not true. The sun is much older than the earth.

THINGS TO DO

1. Gather some pebbles from a stream. Notice that many of the pebbles in the creek are smooth. It must have taken a long time to wear these hard pebbles smooth. How long do you think the smoothest ones have been there?

2. Draw a picture of the way you think the earth looked long ago. Would you have people in your picture? Would there be any tall buildings in your picture?

Forces Which Have Changed the Earth

WATER IS ALWAYS CHANGING THE EARTH

Water is never still for long. It is always going somewhere. Sometimes it is going out to sea. Sometimes it is forming a cloud. It goes into your mouth when you are thirsty. And at other times it is doing any of a dozen other jobs. Yes, water is, indeed, busy.

Because water is always moving, it makes things happen. It really is changing the surface of the earth right

Swift, rushing streams can carry sand and rocks along with them.
The water wears the rocks smooth as it rushes over them

now. It has been changing the earth's surface for centuries. And, what is more, it will keep right on changing the earth for centuries to come.

Perhaps you have never stopped to think about why water moves. It is always going from higher places to lower places. Gravity pulls water downhill. Water runs from higher places to lower places and finally out to sea.

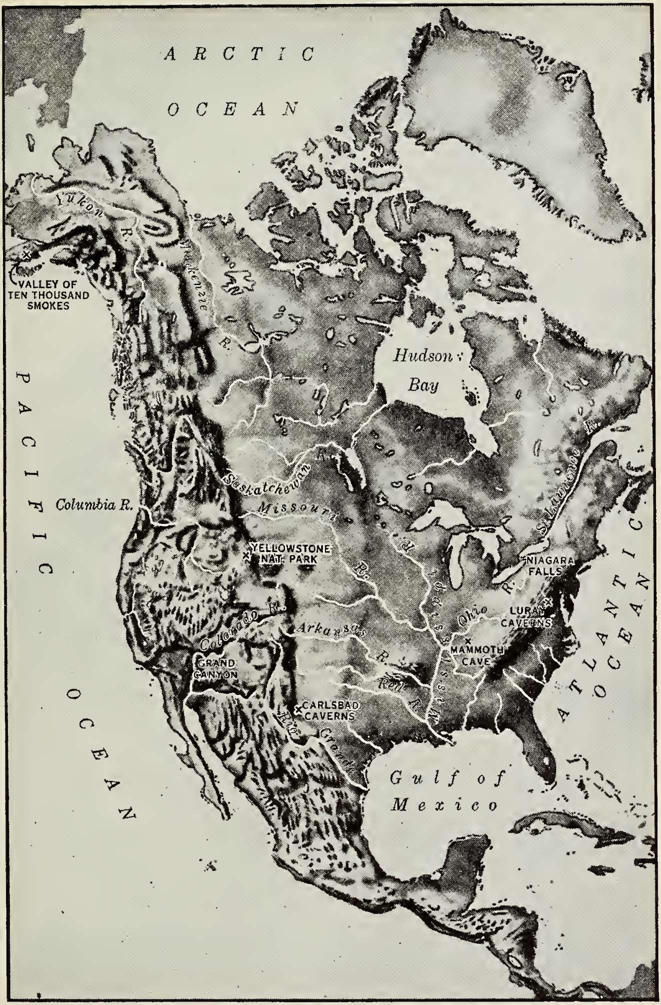
The rivers of North America all finally empty their waters into the oceans. Look at a map of North America. Find the Mississippi River. It flows south and ends in the Gulf of Mexico.

Find the St. Lawrence River. It flows north and east and empties its waters into the Atlantic. Find the Colorado River. It flows southwest into the Pacific Ocean.

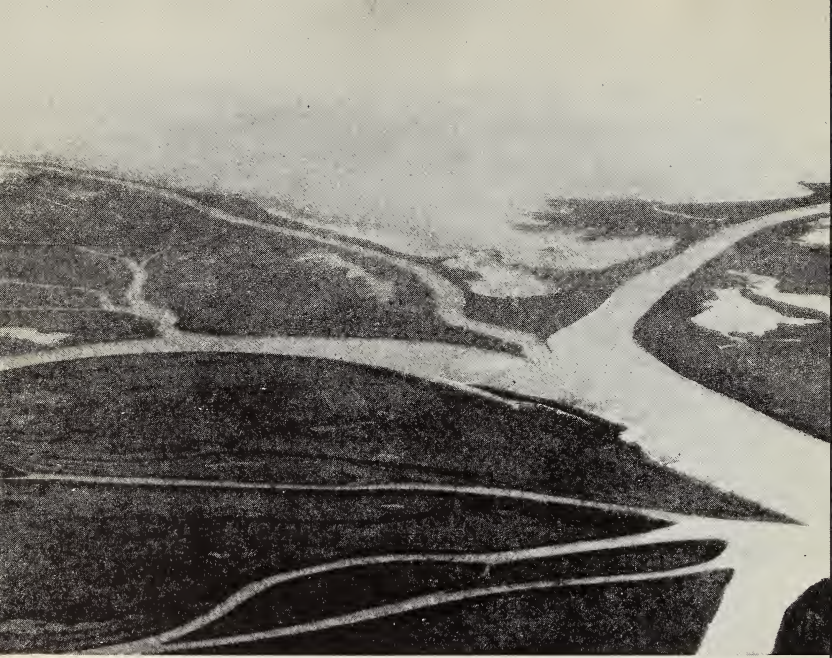
Rivers can flow in any direction: north, south, east, or west. They flow from higher places to lower places in whatever direction that happens to be.

After a hard rainfall the streams are swollen. They have been filled with water which has fallen on the slopes of the earth. These streams are very muddy now, because they are carrying along soil which the water washed into them as it tumbled and rushed down the slopes.

The faster a stream flows, the more soil it can carry. In the flood season of the year the swift streams carry not only soil but rocks, trees, and sometimes houses, cars, and other heavy objects along with them. It is easy for us to see that a great deal of soil is being carried away to other places by a flood stream. But sometimes



Rivers of North America



Davis Aerial Photographic Service

This is a picture of part of the delta of the Mississippi River.
Each year the soil keeps piling up at the mouth of the great river.
Some of this soil was once spread out over farms farther up the river

we forget that every stream is carrying some soil along with it every day. Week in and week out, year in and year out, all streams both big and small are working away at the land and changing it a little.

The Indians called the Mississippi River the "Father of Waters." Each year it carries more mud into the Gulf of Mexico than all the freight trains which enter Chicago could carry. More freight trains go into Chicago than into any other city in the world. Just think how long the "Father of Waters" has been at work! It was working long before the Indians lived here. Year after year it carries tons and tons of mud out to sea.

Every other stream all over the earth is doing what the "Father of Waters" does. They all carry soil along with them. The soil they carry has been worn down from the land over which the water flowed. The water picks it up and carries it away.

Scientists call this wearing down, or carrying away of soil, erosion. If you take a trip into a field near your home or school, you will be sure to find places where the land has been worn down and carried away.

Just see how smooth and round these hundreds of pebbles are.
They have been worn smooth by the water in this stream.
How long do you think it took to make them so smooth?

United States Geological Survey

Look at some pebbles along a stream. Most of them will be worn smooth and round by the water. All the sharp edges of the pebbles and rocks are worn away by the water.

After a hard rain, you will see water carrying the soil away. Some of it runs off as rain wash and carries soil with it. Some of the water sinks into the ground. Some of it evaporates, or goes back into the air again. When water evaporates, it changes into water vapor.

It is well for all of us to do all we can to stop the spring floods, which happen far too often in the river valleys of our country. During a flood, good soil is carried from farm lands into the river valleys. It took a long time for this good soil to be formed. If it is washed away, leaving only rock and poor soil behind, our farm land will become poorer and poorer.

In some of its travels, water sometimes forms deep valleys, or canyons, with high, steep sides. The Colorado River has made one of the greatest canyons in the world, known as the Grand Canyon. It is about a mile deep. Each year thousands of people stop to see the Grand Canyon of the Colorado.

Thousands of tourists also visit Niagara Falls. These great falls are the work of water, too. The Niagara River bed is of hard rock. Below the falls the rock is softer. It wears away more easily. As the water whirls at the foot of the falls, it wears back the soft rock. This leaves the limestone hanging at the top of the falls. The falls slowly move farther upstream as pieces of the

This is the Grand Canyon of the Colorado River.
The river has worn this deep cut in the rocks

hard rock are broken off. Seven miles of rock have been worn away in this manner.

Water sometimes flows in great streams under the ground. As it flows along, it wears away the softer rock. Sometimes parts of the rock are dissolved in the water

Fairchild Aerial Surveys

The great waters at Niagara Falls are slowly wearing the rocks farther and farther bac

just as sugar is dissolved in water. Great caves and caverns are formed. Mammoth Cave in Kentucky was the work of water. The Luray Caverns in Virginia and the Howe Caverns in New York are the result of streams under the ground. In New Mexico the great Carlsbad Caverns were formed in the same way.

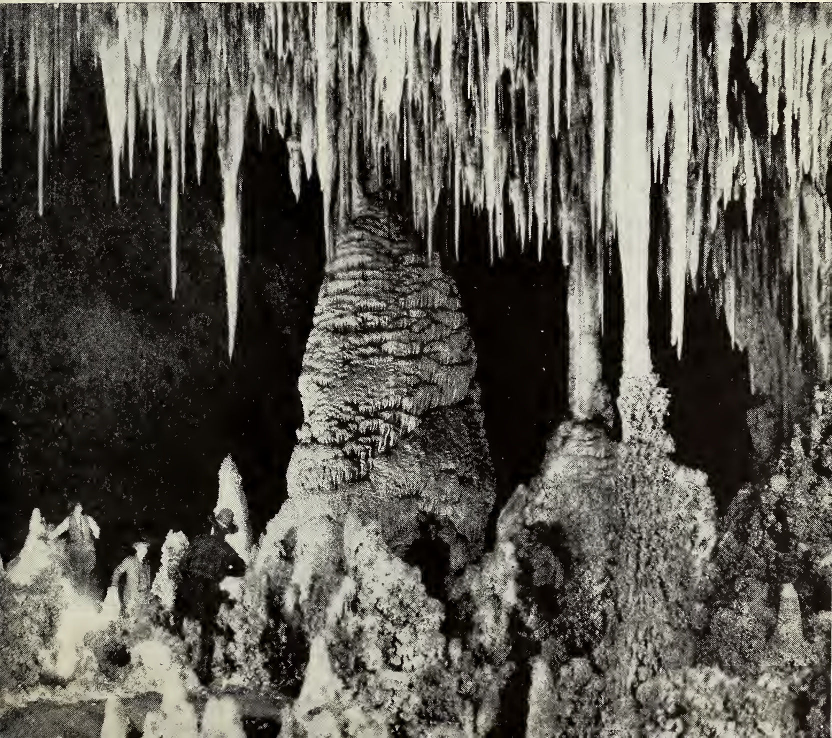
There are some places on the earth where hot water and steam shoot out of the ground with great force.

Streams of hot water and steam which shoot from the ground are called geysers. Hot rocks down inside the earth heat the water under the ground, turning some of it into steam. The steam pushes its way to the surface and blows the hot water into the air. When the steam is all gone, the water no longer shoots out.

Some geysers erupt, or shoot out, water and steam at regular times. Old Faithful, in Yellowstone Park, does this. Once every sixty-five minutes it shoots a stream of water into the air.

For centuries water flowed underground making this beautiful cave

© Santa Fé System Lines



The three great geyser regions of the world are in Yellowstone Park, in southwestern Iceland, and in New Zealand. Giant Geyser in Yellowstone Park shoots water into the air a distance of two hundred feet. The Great Geyser in Iceland has an opening ten feet in diameter.

In Alaska there is a place called the Valley of Ten Thousand Smokes. This region gives out steam and other gases from holes in the earth. Can you see how it got its name?

As geysers erupt, water and minerals fall down near the opening. These minerals keep building up around the opening, just as you see in the picture.

So water goes on wearing away the earth, moving parts of it from higher to lower places. It is lucky for us that water is not the only force which changes the earth. There are other forces which build up the land. There is no danger that all the land will be carried out to sea.

Some of the water in the streams, lakes, and oceans goes back into the air again. How do you suppose it gets there? This experiment may help you to find the answer:

Heat a quart of water. Let it boil for fifteen minutes. What has happened to some of the water? It has gone into the air. We say it has evaporated. When water boils it evaporates.

But evaporation goes on all the time. Usually the warmer the temperature, the more rapidly water evaporates. You can prove this for yourself. Put a quart of

Galloway

What a giant stream of hot water is shooting out
of this great geyser in Yellowstone Park

Water from rivers, lakes, and oceans is always evaporating and going back into the air. Later it gets back again into the streams and lakes and oceans

water into each of three open pans of the same size. Put one pan in a cold place. Put another pan in a slightly warm place. Put the third in a very warm place. Look at each pan daily. You will be surprised at how rapidly the third pan of water disappears.

Sometimes the air is drier than at other times, and in some places it is drier than in other places. The air in a desert, for example, is very dry. If you hung your clothes out on a line to dry in the desert air, they would dry very quickly. Evaporation goes on rapidly in hot, dry air.

The amount of water vapor in the air has a great deal to do with our health. For this reason it is important for us to keep the air in our homes and school moist, or damp. The air in crowded rooms, however, is likely to become too moist for good health. Then evaporation goes on too slowly. You feel warm and uncomfortable because your perspiration does not go into the air freely. If the air is kept in the right condition, this will not happen.

In the winter the air in your houses is likely to be too dry. In this case evaporation goes on rapidly. As a result you may feel chilly, even though the room temperature is 70° Fahrenheit, because your perspiration evaporates rapidly.

The more you perspire, the cooler you feel. Evaporation uses heat. It makes your body feel cooler. Try not wiping your hands after you wash them. As they dry in the air, you will notice that your hands feel cool. The water in evaporating takes some heat from your body, making you feel cooler.

Wherever there is water, evaporation is usually taking place. Water leaves the rivers, lakes, and oceans and becomes a part of the air. Whenever the air gets more water vapor than it can hold, the vapor condenses and we have rain,, snow, or hail.

If you have an aquarium with a glass cover, you will notice drops of water collecting on the inside of the glass top. These drops fall back into the aquarium as drops of rain.

Water is a great traveler. Because of evaporation, water gets into the air. And because of condensation and gravity, water falls to earth again to erode, or wear away, the land.

It is a good thing for you that water keeps on traveling. If it did not, all the water would finally get to the oceans and stay there. All plants and animals on the earth would die if they could not get water. And they could not, if water were not such a great traveler.

GLACIERS ARE ALWAYS CHANGING THE EARTH

Glaciers change the looks of the earth. They are formed in the upper valleys of very high mountains. In these places more snow falls during a year than can melt. Year after year the snow keeps piling higher and higher. As it piles, it presses heavily on the snow at the bottom of the pile. The pressure turns some of this snow into ice. When the mass, or heap, of snow and ice has become so deep and heavy that the top of the mountain cannot hold it, it starts sliding very slowly down the sides. This sliding mass is a glacier. It moves very slowly.

As it moves along, it picks up stones. Some of these moving stones may make deep scratches on the surfaces of rocks over which they pass. The glacier carries away much soil and broken pieces of rock and so scoops out valleys.

The glacier digs its valleys deeper and wider as it slowly moves down the mountain. Finally it reaches

Glaciers form in the high mountains and move slowly down into the valleys below. They are great rivers of ice that wear away the earth

a point where the ice starts melting at the lower edge of the glacier. Here it drops its load of stones and soil. Some of the ground-up rock is carried off by streams of water formed from the melting ice. The rest of it just stays where it is dropped and is slowly worn away by wind and water.

Several great ice sheets have come down from the north at different times. The last ice sheet covered all of Canada and much of the northern part of the United States. In some places it was a mile or more deep. Dur-

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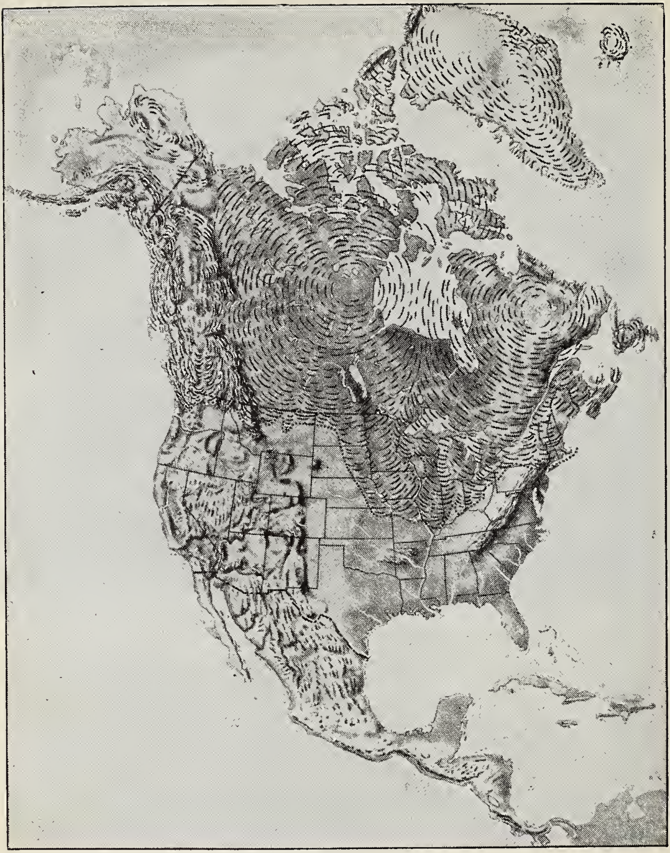


The last great ice sheet covered all of Canada and much of the northern part of the United States

ing this last Ice Age the ice sheet moved backward and forward several times. It would move forward for a while; then it would melt. Then it would move forward.

The last ice sheet lasted for many, many years, until the climate became warmer. Then it slowly melted away, its edge creeping farther and farther north.

Great changes were made in the land over which the ice sheet passed. Mountains were worn down. Valleys were made deeper and wider. Great hills had their tops carried away. Hills and mounds were built up by deposits of gravel, sand, or rock. Rocks and soil were carried for hundreds of miles. New rivers were formed. Lakes large and small were made. In fact, the Great Lakes were formed at this time.

If you live in a region over which the ice sheet passed, you may be able to see signs of it. Look for great glacial scratches on rocks. Look for round hills whose tops have been carried off. Great rocks may be scattered here and there.

Many gravel pits also may prove whether the ice sheet passed that way. Here the glacier left rocks and dirt as it melted away.

Admiral Byrd and his men had many experiences with the ice cap and glaciers of Antarctica. They had to watch carefully for the great cracks which were common in the ice sheet. They spent months upon the great sheet which covers the whole Antarctic Continent.

Another great ice cap, or sheet, is to be found in Greenland. Some scientists believe this may be part of the last great ice sheet which covered North America.

Mount Rainier is famous for its wonderful glaciers. These glaciers move down the mountainside. Perhaps some day you will visit there and see them. You may also visit Glacier National Park.

WIND IS ALWAYS CHANGING THE EARTH

Wind is air in motion. When air moves fast, we say there is a high wind. When air moves slowly, we say there is a breeze. Sometimes the air moves so slowly that we say there is no breeze.

Air is really always moving. It never stops. It is like water in this way. It just keeps on going.

Many years ago a great ice sheet passed over part of North America. It lef many rocks behind as the ice slowly melted. Have you seen places that loo very much like this?

Sawders

American Museum of Natural History

It has taken centuries for the wind to wear these rocks away. The softer rocks wear away, leaving the harder rocks to make such a beautiful sight

It is because air is always in motion that it is such a force in changing the earth. If it stood still, it probably would not do many of the things it does.

Air moves because some parts of the earth are warmer than other parts. The heat from the earth warms the air above it. As air becomes warm, it expands.

Cold air is heavier than warm air. It pushes in toward the warmer parts of the earth and pushes the light, warm air up. This cold air in turn gets warm, expands, and is pushed up by more cold air which is pushing in to be warmed.

Moving air carries bits of soil and sand along with it. It blows against hills and mountains and valleys, wearing them down very slowly. Fast-moving air carries larger objects along with it. Sometimes it picks up cars, trees, and rocks, and does much damage to homes and crops.

The work of moving air has changed the earth a great deal. It works slowly, to be sure, but it never stops to sleep or eat or rest as we do. Let us see some of the things it does.

The sands of the desert are moved about a great deal by air. There is no grass to hold the sand to the earth. In Egypt, on the edge of the great Sahara Desert, men have watched the moving of the sands. Many great tombs of the rulers of Egypt have been buried by the moving sands. Later they have been uncovered again.

Along the shores of lakes and oceans you often find the sand piled up in heaps called dunes. Year after year these dunes keep moving from place to place; and all because of the force of moving air.

Air is always carrying some sand and bits of dust along with it. As it blows against mountains and valleys, these bits of sand hit against other bits of sand and help to wear the mountains away. The stronger the wind, the more soil, sand, and dust it can carry. The more the wind carries, the greater is its force to wear away rocks and soils.

Dust is often carried great distances by wind. During the dust storms of the last few years in the United

Keystone

Great dust storms like this have swept across the southwestern part of the United States carrying away the rich topsoil of the farms

States, dust from the southwest has been carried to Boston and far out into the Atlantic.

Dust from the Sahara Desert in Africa has blown across the Mediterranean Sea and into Italy, Germany, and France, and even as far as England.

It is easier for wind to move dirt about than to move solid earth about. Today parts of North America are facing the danger of becoming a large desert region. And here is the reason:

When the pioneers pushed on to settle the western plains, they found great herds of buffaloes living on the sodded lands. The pioneers did not wish to make their living by keeping buffaloes. They killed the buffaloes for food and for their hides. They wanted to become farmers. In order to work the farms they plowed the buffalo grass under and planted corn, beans, wheat, oats, potatoes, and other crops.

The western plains became huge farms, and this seemed good to the men who were farming the land and making money. They just kept on plowing the sod under. They left the soil free to be blown away whenever there was no rain and the soil became very dry. And blow away it did. And blow away it always will unless man hurries to stop it.

Great dust storms have swept across the country. Some of the storms have been so severe as to hide the light of the sun. Cattle and people have died because they breathed so much dust. Roads, houses, and railway tracks have been buried by the dust.

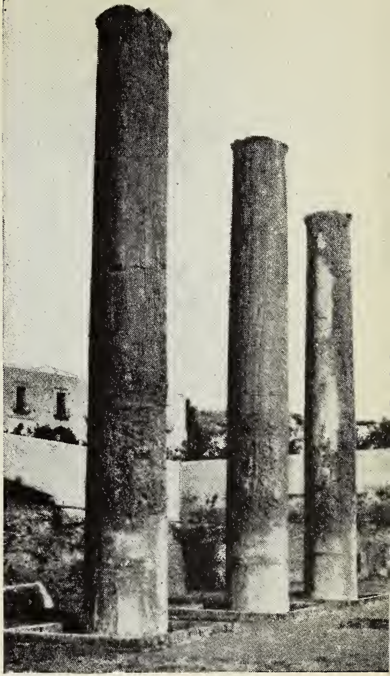
Wind is sometimes helpful and sometimes harmful to man. Man can stop much of the harm that wind does by making his buildings in such a way that they cannot be blown down. He can keep good soil from blowing away by planting trees and other plants.

FORCES INSIDE THE EARTH ARE ALWAYS CHANGING THE EARTH

Some Forces Build Up the Earth. You have been reading about wind and water, which keep on wearing the earth away. Perhaps you have wondered why the land has not all been carried out to sea or blown away. Here is the reason: While these forces are at work tearing down the earth, other forces are at work building up the earth.

We call water and air erosion agents, because they wear away the land. But there are forces inside the earth which do not act this way. These forces inside the earth build up the land instead of tearing it down.

We know that there has been this building up of land along many seashores. In some parts of the earth, cliffs once cut by ocean waves now lie far back from the shore.



Galloway

Parts of these columns were once under the water. You can see the water mark on each of the columns. The columns are now high above water

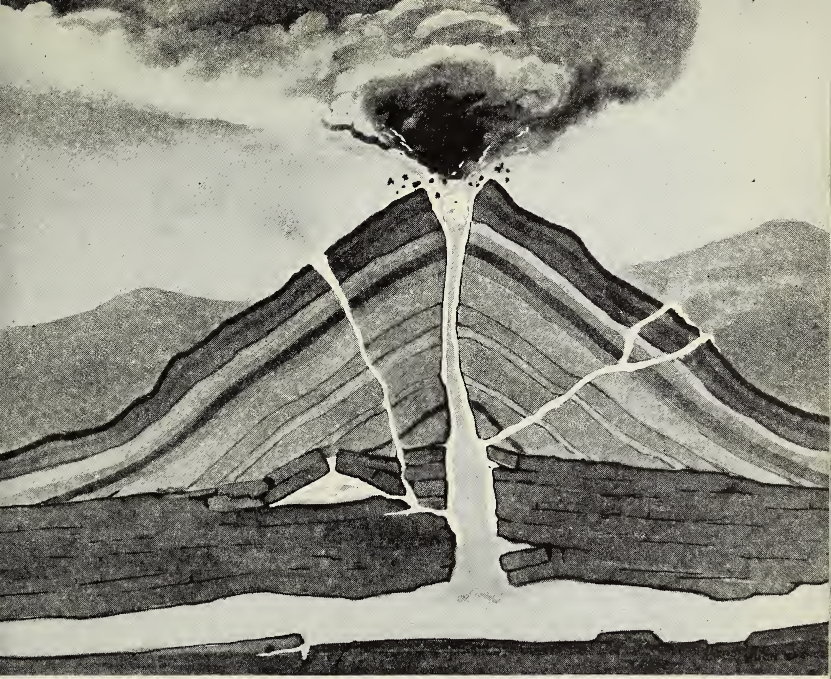
There is a temple near Naples, Italy, which was built centuries ago by the Romans. This temple was once partly covered by sea water as its ruins now show. Of course the temple was built on land which later sank, and still later rose again.

In several places far from the seashore and high up on the sides and tops of mountains all kinds of shells have been found in the rocks. These were left there when water covered that region and when there were no mountains there. Since then the land has risen and the sea has disappeared.

It is really a good thing that both forces are working on the earth. One force weathers, or wears down, the land. The other force builds up the land. We know that water, wind, and ice wear land away. We know, too, that these same three things also build land up again. They carry soil from one place and put it down in other places. Let us now find out more about these forces.

Volcanoes Build Up the Earth. One of the forces which affects, or changes, the land is that which causes volcanoes. Scientists do not fully understand the cause of volcanoes. They know that there is heat inside the earth. They believe that this heat has a good deal to do with causing volcanoes.

Many scientists think that there are places something like pockets, or wells, in the rocks beneath the surface. These wells fill up with hot molten, or melted, rock and gases. When the wells become very full, the molten rock and gases try to break through. In other words, they press against the rocks on all sides. Wherever there is a weak place or a crack in the rocks, the melted rock and gases break through. Sometimes the force is so great that an explosion takes place. When the materials cause an explosion at the surface, we say a volcano has erupted. Sometimes melted rock and gases flow gently out of the cracks in the ground instead of causing an explosion.



This drawing shows you how hot melted rock called lava breaks through the crust of the earth and shoots into the air above, causing a volcanic eruption

When there is an explosion, water vapor, steam, and other gases, solid rocks, ashes, and molten rock shoot into the air. The molten rock is called lava. The hot lava flows down the sides of the volcano. When it cools, it leaves the land around it a little higher than it was before. We call the raised part a volcanic hill or cone.

If you have never seen a volcano erupting, you might get an idea of how it works by doing this experiment: Cook some oatmeal or other cereal. As it boils, there will be small explosions caused by hot steam reaching the surface. As the cereal bubbles up, it is something like a volcano erupting. Notice the hole that is left where the explosion takes place. This is like the crater of the volcano.

Sometimes volcanoes erupt only a few times and then remain quiet for years and years. Other volcanoes keep on erupting. When it is thought that a volcano will never erupt again, it is called extinct.

In the Hawaiian Islands there is a famous volcano which is always active. The inside of the crater is boiling and bubbling up just like the cereal you watched.

Volcanoes have been erupting off and on all through the long history of the earth. Each eruption changed the land a little. Many islands in the ocean have been formed by volcanic eruptions.

Use your world map again. Find the Columbia and Snake rivers, which are in the northwestern part of the United States. Over this great region lava poured and poured, building up the land. When you visit the western part of the United States, you will see great lava beds which have built up the land there.

Try to find other mountain regions which have been changed by volcanic eruptions. Can you find Mount Vesuvius and Fujiyama and Mount Pelée?

There are many quiet and extinct volcanoes scattered over North America. Only one has erupted within the present century. Mount Lassen is its name. It erupted in 1916. Can you find it on your map?

Army Air Corps, from Keystone

This is a picture of Mauna Loa in Hawaii, during an eruption. This volcano is very active

As you travel about, you may visit volcanic mountains which the United States and Canadian governments preserve for visitors to see.

It sometimes happens that the liquid rock does not erupt above the surface. Since the hot rock, or lava, and steam are not strong enough to break through the top, they pour into cracks in the rock below the surface, sometimes melting the other rock in doing so. The lava flows in between the layers of rock and in so doing raises the land.

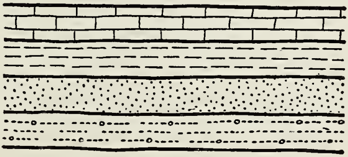
If you wish, you can make a small model that will help you to understand how lava flows between layers of rock. Place an open tube of paste inside a heap of small stones. Now press on the stones. The soft paste will go out of the open tube in between the stones. Let it harden. It will look something like lava which cools between the layers of rock. When a great deal of this molten rock flows into the cracks, it raises the land above.

Fujiyama is a beautiful mountain in Japan.
It is a volcanic mountain but has not erupted for many years

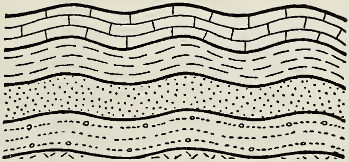
Burton Holmes from Galloway

Folding of the Earth Causes Changes. There have been periods in the earth's history when the layers of rock in the earth were heaped up and made into mountains. This heaping up of rock is called folding.

When the layers of rock were laid down, they were formed in straight layers like this:



But great pressure from beneath them and along their sides folded them up and made them look like this:



The tops of the folds became mountains, and the bottoms of the folds became valleys.

It was in some of these great folding periods that the Appalachian Mountains were formed. In a much later folding period the Rocky Mountains were formed.

The Rocky Mountains are much higher than the Appalachians. The reason for this is that they are younger. Once the Appalachians were as high as the Rocky Mountains are now. But they are so much older than the Rockies that they have been worn down more.

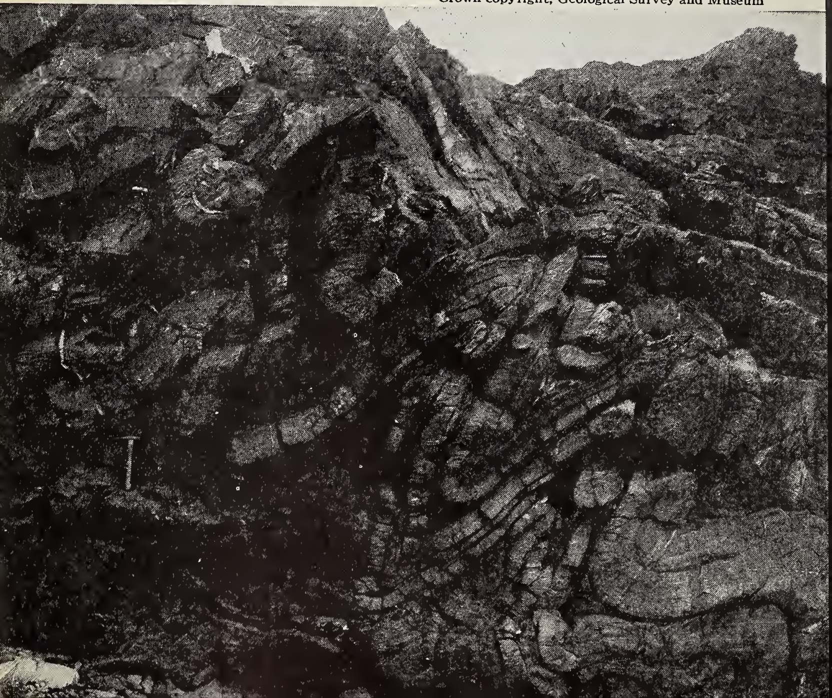
The Alps in Switzerland are young mountains. They are very high. As time goes on, these mountains may wear down, too.

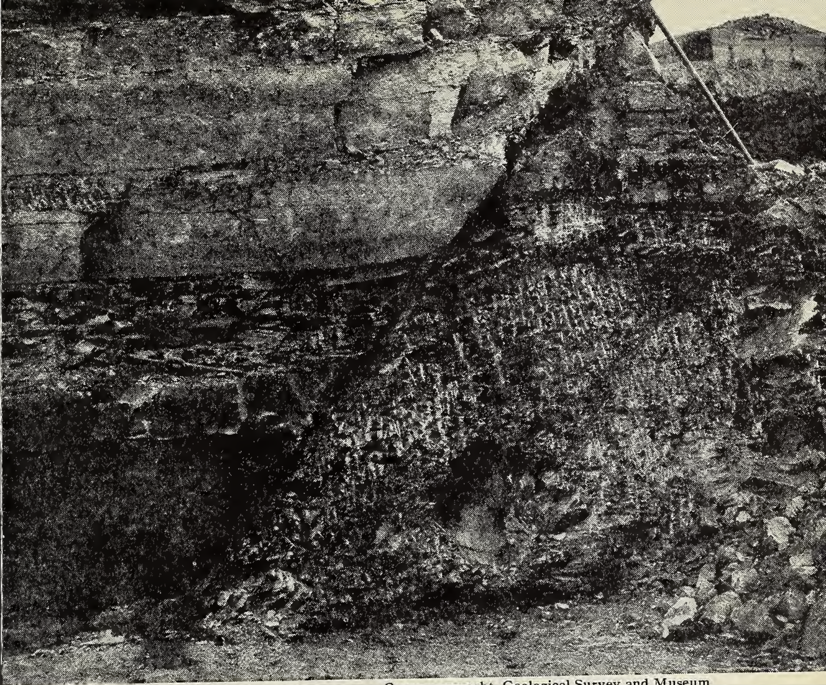
You can see how folding takes place. Lay a piece of paper or cardboard flat on your desk. Now push each edge toward the other, keeping the edges of the paper on the desk. What happens? Do you have paper hills now?

Inside the earth there are forces which have pushed and pushed in much the same way. They have wrinkled the surface of the earth, making mountains and valleys.

These rock layers have been folded by great pressure

Crown copyright, Geological Survey and Museum





Crown copyright, Geological Survey and Museum

Pressure was great enough to break the layers of rock, causing a fault in the rocks

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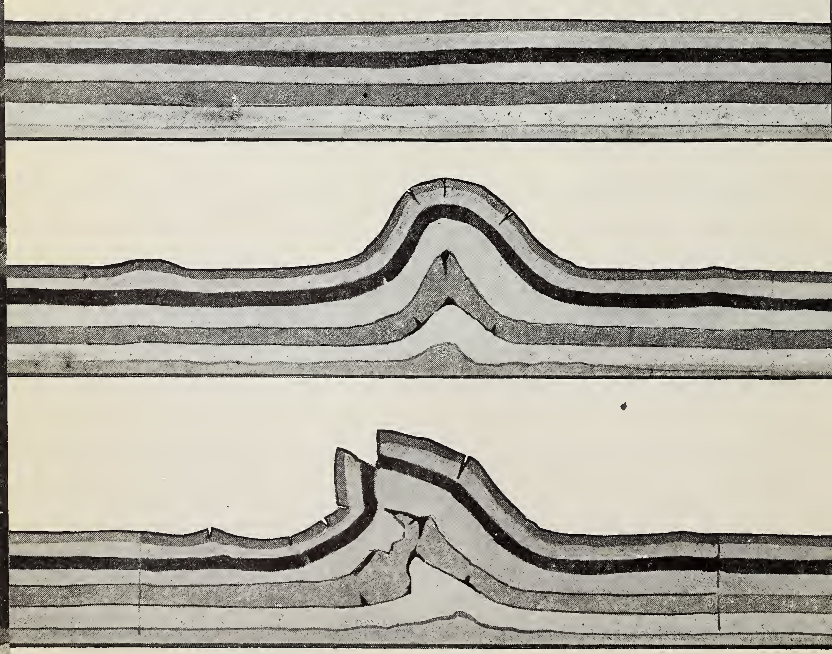
Of course mountains are made neither in a few minutes nor in a few years. It takes more years than you can count for mountains to be made. It is slow work, just as erosion is slow work. One's life is so short that you may never notice that the mountains near you are changing. But they are, ever so slowly.

Sometime there is such great pressure on the layers of rock while they are folding that one or more of the layers crack. The layers are then pushed up unevenly, causing a "fault" in the rocks. The picture above shows the crack in the layers of rock. Notice how the layers have been pushed up at the crack. Have you ever seen layers of rock which have cracked and been pushed up like those in the picture?

Earthquakes Change the Earth's Surface. Have you ever pressed so hard on the two ends of a stick that it broke? First the stick bent. Then snap, crack! It broke. You pressed so hard that the stick had to break.

So it may be with the earth's surface. The earth may fold, and fault lines may be seen. The crust of the earth

This clay-model diagram shows you how layers of rock may become pushed up and finally crack from the great pressur



cracks and shakes. This shaking, or quaking, of the earth is an earthquake.

By using colored modeling clay you can see how this happens. Build up several layers of clay. Be sure the layers are straight. Now press against opposite edges of the clay model at the same time. The layers will fold and wrinkle. Finally the top ones will crack. Here you have seen how the layers of rock inside the earth move and cause earthquakes. Some earthquakes happen near volcanoes. Most earthquakes happen along fault lines, because the rocks are most likely to move there.

Many buildings, railroads, and bridges are damaged when there is an earthquake near them. In the future man must learn to make his buildings to "ride" the quakes better, and then he will not need to fear them.

Someone has planned an earthquake-proof house. If the house moves, it all moves together as one house. It does not fall apart.

In 1923, Tokyo, Japan, had a terrible earthquake. Thousands of people were killed by the falling buildings, the fire which followed the quake, and the great sea waves and storm which swept the area.

Japan lies in the belt, or path, of earthquakes which runs through the ocean to the east. It has had many quakes and is still having them. During the seven years between 1885 and 1892 more than 8000 quakes were recorded in Japan. Most of these were so slight that no one but scientists knew about them. The scientists watched the quakes being recorded on a machine.

Acme

The ruins of a large building after an earthquake

Earthquakes are much more frequent than most people believe. One scientist says that there is a quake every thirty minutes. As these quakes happen, the land may be changed a bit.

THINGS TO THINK ABOUT

1. It is no wonder that the earth has greatly changed in such a long, long period of time. If you stop to think about it, you may be surprised that more changes have not taken place. Although there are great forces at work, they usually seem to work very slowly. Wind, water, and ice are powerful forces. They have been working for centuries wearing down the land.

2. These same forces have been at work carrying the land from certain places to other places. So they not only wear down the land; they also build it up again in other places. Volcanoes and geysers help to build up the land, too.

THINGS TO DO

1. Fill the blanks in the sentences below with words from the following list. Use the words that will make the statements true. (*Do not write in the book.*)

warm
many
water
desert
forest
cool
erosion
glacier
wind
river

a. It has taken ---?--- years for the earth to change its looks.
b. Wearing away of land is called ---?---.
c. Water usually evaporates more quickly on a ---?--- day than on a ---?--- day.
d. A river of ice is called a ---?---.
e. ---?--- and ---?--- are two forces which have changed the earth's surface.

2. Visit places in your neighborhood where you can study the rocks. What story do these rocks tell you about the many great changes which have taken place upon the earth?

3. Collect pictures which show how the earth is changing. Include ones of volcanoes, glaciers, flooded streams, and geysers.

III

The Air and How It Works

THE AIR WE BREATHE

THE WEIGHT AND TEMPERATURE OF THE AIR

WIND DOES BOTH HARM AND GOOD

YOU know that the air is a real part of the earth. It makes a kind of blanket around the land and water parts of the earth. It is found even in the water and in between the bits of soil. There is no place on the earth where there is no air. We usually do not think about the air unless the wind is very strong; but it is very important.

In this story you can find out what the air really is and what it does. Even though the air is not a living thing, all living things on the earth must have air.

THE PICTURE ON PAGE 117 IS FROM A PAINTING BY BEN STAHL.

The Air We Breathe

WHAT AIR IS MADE OF

You have already read much about the air. You know that air forms a blanket which goes all around the earth. You know that it has weight and that it presses against everything it touches. You know that it is a great force in wearing down and building up the earth.

You know that the air is thickest near the earth, and that the higher you go, the thinner it is. The air helps to keep the temperature from rising too high during the day by keeping some of the heat of the sun from getting to the earth. It also helps to hold the heat to the earth so that the temperature does not fall too low at night.

But these are not the only things you can learn about the air. There are many more things for you to learn about it; and one of these has to do with the question What is air?

Air is a mixture. It contains many gases and small bits of dust. If you were making air as your mother makes a cake, the recipe would look something like this:

Put four fifths of a cup of nitrogen gas into a closed dish.
Add one fifth of a cup of oxygen gas.
Add a pinch of carbon dioxide gas, and a dash of other gases and dust.
Cover carefully and shake until all is well mixed.

If you followed the directions carefully, you would have a good mixture of air.

You do not have to make the air you breathe. It is ready and waiting to be used, at your very nose. It is everywhere about you, and you are so used to having it ready-made that you are very likely to forget just how important it is.

Did you ever try holding your breath? If you have, you know how very uncomfortable you become in a few seconds. When you hold your breath, you stop breathing air. If you could not breathe air, you would soon die. So, you see, air is very important to us.

THE OXYGEN IN THE AIR

The one part of the air which we can use just as we find it is the oxygen part. It is the gas which our bodies use. Although we breathe in the other things in the air, we just breathe them out again. But we keep some of the oxygen we breathe in. It is taken up by the blood and sent to all parts of our bodies, where it is used in giving us energy.

Man is not the only living thing that needs oxygen. Plants and other animals need it as well. Plants take it in through little openings in their leaves. Fish take it in through their gills, which are little openings on the sides of their heads. Other animals breathe it through their lungs.

Whether you are awake or asleep, you still must breathe. Sometimes you breathe faster than at other times. If you are running a race, you breathe very rapidly. While you sleep, you breathe more slowly. So it is with horses, dogs, cats, and other animals. Sometimes they breathe slowly, and sometimes they breathe rapidly.

Did you ever watch a fish out of water? It cannot live long. A fish can get oxygen only from water and through its gills, and so it is very uncomfortable out of water.

It is very different with us. We cannot get oxygen from water. We have to hold our breath when we dive. We can swim a short distance under water. But very soon we have to come to the surface to breathe.

The eggs of frogs will hatch into tadpoles. All tadpoles take in air through gills, just as fish do. When the tadpoles turn to frogs, they lose their gills and breathe through lungs. If you watch carefully enough every day, you may see the changes in a tadpole as it turns into a frog. Be sure to remember that as soon as the gills are gone, the frog must breathe the air through his lungs. Give him a stone or board to hop upon. If you leave him in the water and he cannot breathe the air above the water, he will die. He has to come to the top of the water to breathe the air.

If you have ever dug up an animal that hibernates, or sleeps, during cold weather, you have perhaps thought it was dead because you could not see it breathe. Really it was breathing a little, but so little that you could not see it.

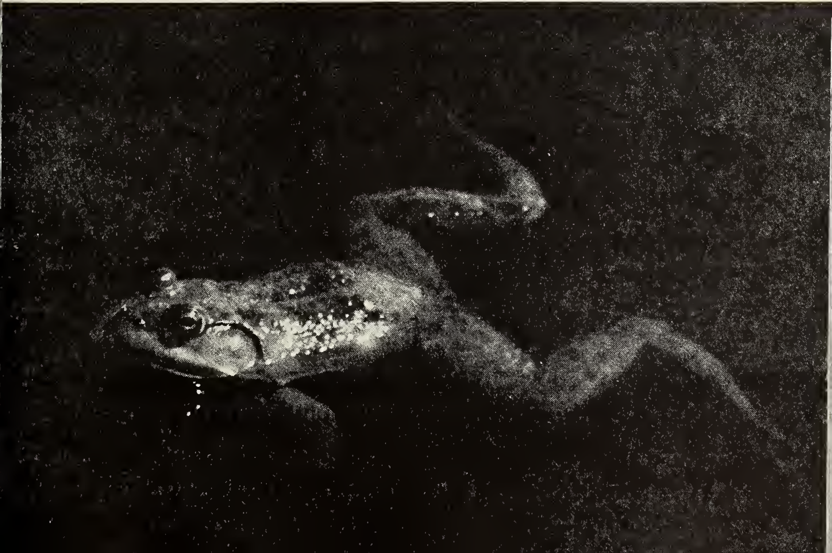
Watch your dog breathe. Take him for a swim or a run and you can not only see him breathe, but you can hear him as well. Watch him when he is asleep. His breathing is much slower and easier.

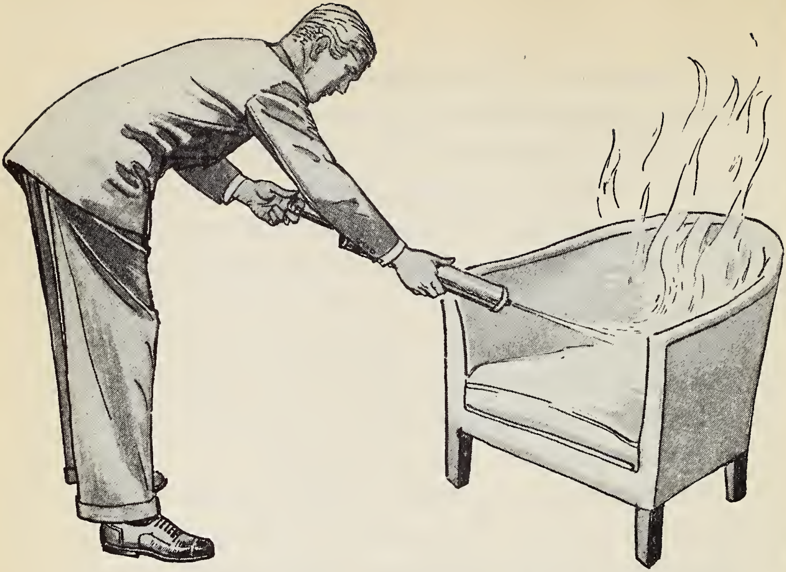
Oxygen is as necessary to fire as it is to plants and animals. When the oxygen grows less, the light gets dimmer and dimmer. It finally goes out. You can prove this very easily. Light a candle. Put a water glass over it. As the supply of oxygen is used up, the candle gets dimmer and dimmer and finally goes out. Light the candle again. Use a larger glass this time. Does it take longer for the candle to go out? Of course fire uses only part of the oxygen in the air in burning.

Perhaps you have helped to build a campfire or a fire in the fireplace. If so, you know how important it is to place the sticks so that air can get at the fire. A

Frogs breathe air through their lungs.
They must come to the surface of the water to get air

Lynwood Chace





A fire-extinguisher puts out a fire by cutting off the supply of oxygen

good fire-builder piles the sticks up in such a way that the air can get through.

When people want to put out fires, they may do it by keeping the oxygen out. Throwing sand on a fire will smother it, because it keeps the oxygen from getting to the wood. A blanket or rug thrown over a small fire will put it out. Water or damp leaves and grass will do as well.

You may have a fire-extinguisher in your school hallway. Buildings, elevators, and homes often have fire-extinguishers. Most of them make carbon dioxide, which pours out over the flame, shutting off the oxygen supply.

Firemen fight fire with water. Everyone knows that wet things do not burn easily. Cities and villages have fire departments. When there is a fire, the big fire hose pours water on the burning material. The water stops the fire by keeping out the supply of oxygen and also by cooling the materials, so that they will not burn so easily.

Here is something to remember: Fire is a very dangerous playmate. *Learn to use it carefully.* Do not get excited if you see someone else in trouble with fire. Keep out the oxygen supply by keeping the air away, if you can, and call for help. You cannot be too careful with fire.

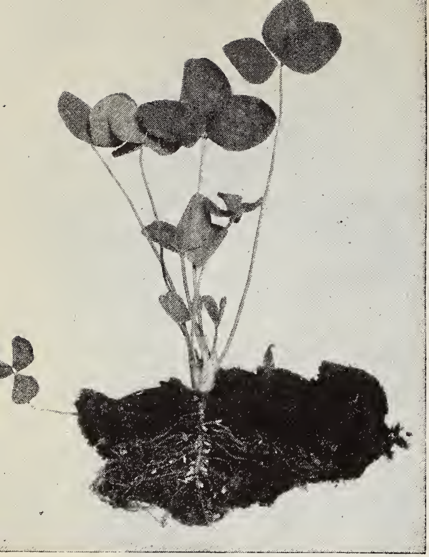
Oxygen works on the wood in houses and barns and slowly makes it look old unless it is painted. It rusts iron. That is why you often see iron painted with red lead. This paint keeps metal from rusting.

Only one fifth of the air is made up of oxygen. This is just the right amount. It is a good thing for us that there is not more oxygen in the air. Oxygen helps us to have energy; but too much oxygen would mean that things would burn too easily and rapidly.

THE NITROGEN IN THE AIR

As you know from the air recipe, four fifths of it is nitrogen. You breathe nitrogen in and out again, and nothing happens to it or to you.

But when nitrogen is mixed with other materials, it becomes very important to us. Although we do not then breathe it, we may eat it.



Clover is useful to farmers. It has tiny lumps on its roots in which bacteria live. These bacteria can take nitrogen from the air

A few plants are able to take nitrogen from the air and put it into the soil. Clover plants do this. Clover plants have small lumps on their roots. Tiny living things called bacteria live in these lumps. These bacteria are able to take the nitrogen from the air in the soil and to change its form. Plants can use the new form of nitrogen. That is why many farmers plow their clover under in order to give the soil nitrogen which other crops can use.

These same wise farmers rotate, or change, their crops in order to keep the soil well supplied with all the minerals which plants use for food. If the same kind of plant is grown on the same piece of land year after year, it will use up the same kinds of food materials in that soil. Soon this piece of land will not produce a good harvest of that plant, because it cannot get the right kind of food from the soil. So we say the farmer rotates, or changes, his crops.

THE CARBON DIOXIDE IN THE AIR

Carbon dioxide is another gas found in the air. You have seen it bubble when you opened a bottle of soda pop. When you get an ice-cream soda at the drugstore, the bubbles you see are caused by carbon dioxide going into the air.

Your mother uses carbon dioxide when she puts baking soda or baking powder into the dough in making a cake. Carbon dioxide makes the cake rise.

You can make some carbon dioxide at school. Put a tablespoonful of baking soda into a glass. Add a little vinegar to it. The bubbles which form are carbon dioxide.

Carbon dioxide is given out into the air by all living things. We give it out along with our breath. It is put into the air whenever anything burns. The fires in factory boilers send much carbon dioxide out through chimneys.

Plants use this gas for making food. It enters the leaves through tiny holes, called pores. Here it is put together with water, and both are changed into food for the plant by the sunlight and the green matter in the leaves. Only a very small part of the air is carbon dioxide, but that is enough for plants to use.

THE WATER VAPOR IN THE AIR

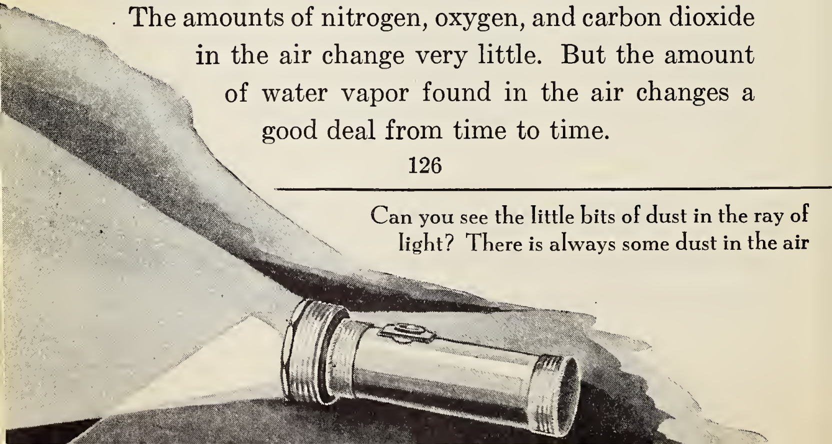
Sometimes air may have more water vapor in it than it does at other times. If the air is dry, there is a small amount of water vapor present. When the air is moist, there is a greater amount present. On days when there is much water vapor in the air we say the air is humid, or that we feel hot and uncomfortable because of the humidity. With more moisture in the air one can be comfortable at a lower temperature.

Every day you have easy ways of proving that there is water vapor in the air. When you take your bath, you sometimes see tiny drops of water on the bathroom mirror. These drops are condensed water vapor which was in the warm air of the room.

If you wear glasses, you are often annoyed as you come into a warm room after having been out in the cold. A cloud of tiny drops of water forms on the glasses.

Did you ever see water vapor of the air condense on the windows of your car? Did you ever see it on the kitchen window when your mother was boiling water in the teakettle? Did you ever breathe upon a cold windowpane and find that it became wet from the moisture in your breath?

The amounts of nitrogen, oxygen, and carbon dioxide in the air change very little. But the amount of water vapor found in the air changes a good deal from time to time.



Can you see the little bits of dust in the ray of light? There is always some dust in the air

THE DUST IN THE AIR

Dust is always present in the air. Usually there is not enough of it to harm us. Really, a little dust is very useful in the air. The raindrops and snowflakes form around it. It helps to control the amount of heat in the air. It adds color to the sunrise or sunset.

If you ever do the dusting at home, you may think dust in the air is just a bother; for no matter how often or how well you dust, there is always some left.

You can show that there is dust in the air. Take a flashlight into a dark room or closet. Turn it on and lay it on a table. Stand off and look at the rays of light. You will see dust moving about in the air.

THINGS TO THINK ABOUT

Miss Bell wrote the following on the board for her children to think about:

1. The air is a mixture of gases.
2. The oxygen of the air is very important to us.
3. Plants use carbon dioxide in making food.
4. Nitrogen helps us by helping plants to grow.
5. Sometimes there is a great deal of water vapor in the air. Sometimes there is only a little.

THINGS TO DO

Make carbon dioxide by mixing soda with vinegar. Wait until the soda and vinegar stop bubbling. Now light a candle. Dip the flame in the carbon dioxide. Does the flame burn?

The Weight and Temperature of the Air

AIR PUSHES AGAINST THINGS

Everything has weight. As air is something, it must have weight. You can feel the weight of air as it blows against you.

You may wonder why you do not notice the weight of air more than you do. That is easy to explain. The air is pressing against every part of you with the same pressure, or push. It is pressing down on your hand, but it is also pressing up on your hand, since air is all around your hand. These pressures are equal; so you do not feel them. The air enters your body. It presses inside as well as outside your body; so you do not feel it pushing on the outside.

Perhaps this experiment will help you to see that the air has pressure. **Do not do this alone; it is a little dangerous. Ask your teacher to help you,** so that there will not be an accident.

Find a metal gallon can with a stopper. Can you make a dent in it with your hands? Can you dent it with a hammer? You would have to hit it hard to dent it much, would you not? Stand on it. Does it hold you up without denting?

Place a board on the can. See if two children can stand on it without denting it. Do you think it would take much force to dent it?

Now put a little water in the can and place it over heat. Be sure that the hole is open for the steam to come out. **Do not cork the can yet.** Let the water boil. Soon you will see a white cloud of small drops of water just above the hole in the can. This white cloud is formed when the steam cools and condenses. As it comes out, the steam pushes most of the air out of the can. Is there much air in the can now?

Steam takes up more room than water does. When the steam is coming out fast, take the can away from the fire and put a rubber stopper in the hole of the can. Fit the stopper tightly. **Be sure to take the can from the heat before putting the stopper in the hole.** Set it aside to cool. Watch it as it cools. The sides of the can will cave in. What do you think causes the sides to cave in?

The rubber stopper is pushed down into the can. Try to pull the stopper out. It is hard to do so.

When the can was hot, it was filled with steam. The steam turned back to water as the can cooled. Water does not take up so much room as steam. The water that did not turn to steam stayed at the bottom of the can. The rest of the can was almost empty. The steam had pushed most of the air out.

There was air outside the can. This air had force. It had pressure. There was almost no air and only a little water inside the can. The air outside of the can pressed against the sides of the can and made them cave in. Are you surprised to find that air presses hard enough to make this happen? It presses all the time on everything.

Sometimes it presses harder than at other times. But it always presses against everything on the earth.

THE TEMPERATURE OF THE AIR CAN BE MEASURED

The pressure of air changes. So does its temperature. Some days the air is very warm. Other days it is very cold.

Air temperature is measured with a thermometer. The Fahrenheit thermometer is used in your school. On this thermometer 32° is the freezing point and 212° is the boiling point of water.

A thermometer works in this way: There is a glass tube closed at one end and ending in a bulb at the other end. The bulb and tube have a silvery-looking liquid, called mercury, in them. As the mercury is warmed, it expands and rises in the tube. As it cools, it contracts and falls in the tube. Often a liquid called alcohol, which has been colored red, is used instead of mercury. It works just as mercury does.

In some places changes of forty degrees in temperature happen within a day or two. Places which are very hot during the day may cool off very quickly at night.

Have you ever let your thermometer help you decide how to dress? Many children learn to read the thermometer. They read it every morning. They know then whether to wear very warm clothing or not. If the thermometer reads 68°, do you want to wear a heavy coat and sweater? When it reads 32°, what do you wear?

THINGS TO THINK ABOUT

1. Air is a great pusher. It has force equal to about fifteen pounds of pressure to the square inch. This figure is a square inch:

Use your scales to find out how many of your books it takes to weigh fifteen pounds. Lift the books, and see what a weight of fifteen pounds really is. Then you will understand why we say that air is a great pusher.

2. The temperature of the air makes a great difference in the way things live and grow upon the earth. Very cold places are rather bare places. Most plants cannot grow in cold, cold places. In temperate climates there is much plant life. Many people like to live in the places on the earth where it is neither too hot nor too cold.

THINGS TO DO

1. Keep a temperature chart for a month. Write down the temperature each day at noon. See how the outdoor temperature of the air changes.

2. Weigh objects to find out just what a weight of fifteen pounds is. The air presses on every inch of the inside and outside of our bodies with about this amount of pressure.

Wind Does Both Harm and Good

HOW AIR BECOMES WIND

Wind is air in motion. It makes things move. It makes the clouds sail across the sky. It throws the great waves of the ocean against the shore. It picks up sand and dirt and carries it for miles. In bad storms it even blows buildings over. It blows seeds about.

Wind is very useful. In Holland people use the wind to turn large windmills which pump water through the canals. Farmers in other countries use the wind for

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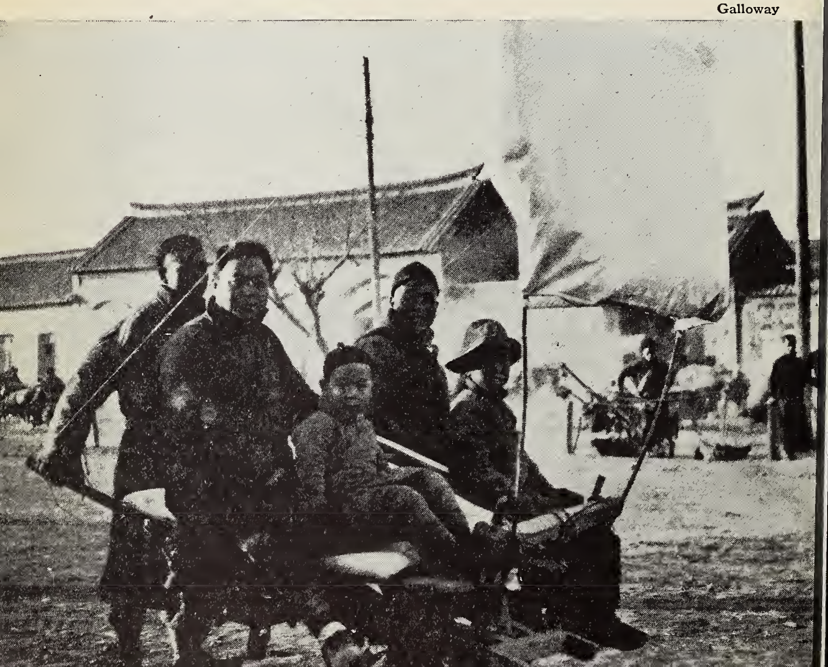
n Holland windmills like these are used to pump the water through the canals

De Cou, from Galloway

turning mills to pump water for their farms. Sailing boats need wind to blow against their sails and make them move. One of the first trains ever made had sails on its cars, so that the wind would help to move it along the tracks.

In China men have sails on wheelbarrows. The sails help the men to haul very heavy loads. Can you think of any other ways in which wind is useful to people?

When you watch the wind, you almost think it is alive. But of course it is not. Wind is only moving air. Should you like to learn what makes air move? If so,



In China sails were used on wheelbarrows.
The sails caught the wind and helped move the wheelbarrov

Galloway

read these experiments carefully. Get your teacher or your parents to help you to do them.

Experiment 1. Get a small box. A chalk box would be just right. Get a piece of glass just the right size to use as a side for the box. Bore two holes in the top of the box. Bore the holes far enough apart so that you can place a lamp chimney over each hole. Place the chimneys over the two holes. Light a short candle and put it inside the box just under one of the holes. Next crush a piece of paper. Wet the paper with a little water. Then light it. It will only smoke. It will not catch fire. Hold this smoking paper over first one lamp chimney and then the other. Over which one does the smoke rise? Over which one does it go down into the chimney? The smoke moves with the moving air. Can you tell why the smoke rises over the chimney which has the candle beneath it? If you can answer the following questions, you will know why the smoke rises over that chimney:

1. What did the candle do to the air in the chimney?
2. When air gets warmer, does it get lighter or heavier?
3. Where did the cooler air come from which was pushing the warmer air up?

Experiment 2. Put a piece of paper on the ventilator. It will cling to it if the air is leaving the room, and blow away from it if the air is coming in.

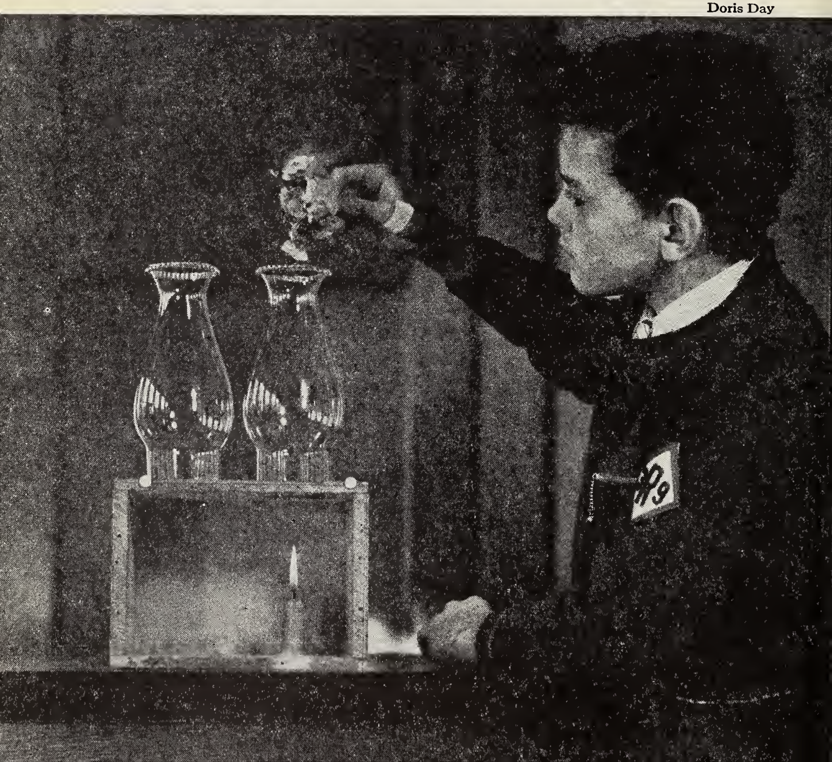
UNEQUAL HEATING OF THE EARTH CAUSES WIND

The sun heats the earth. It makes some places warmer than other places. Most things expand, or spread out, when they are heated. Air is like that. It needs more room when it is heated.

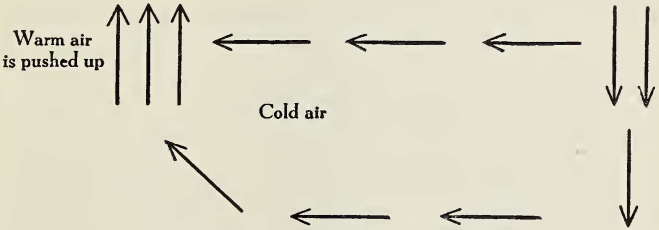
As the air is warmed in some parts of the earth, it expands. As it expands, it also gets thinner. It spreads out in all directions. The more it spreads out, the thin-

Over which lamp chimney would the warm air be rising?

Doris Day



ner it gets. When air has become warm, there is less of it in the same space than there was when it was cool; so it weighs less.



Now over other parts of the earth the air has not been heated. It is cold. It has not expanded. It is heavier than the warm air. This cold air pushes in toward the warm air, because it is heavier than the warm air. The heavier, cold air pushes the lighter, warm air up. The cold air takes its place.

What will happen to the cold air which has pushed the warm air up? Do you think it will now become warm? If it does, it will expand and get lighter. Then more cold air will push it up, too. This movement of cold air pushing warm air up is what makes the wind. It makes air move. Moving air is wind. If the cold air rushes in to push the warm air up, we have a hard wind. If it moves slowly, we have a gentle wind.

Air is always moving. Outdoor air moves faster than air inside buildings. We do not often feel a hard wind indoors. This does not mean that the air inside is not moving. Air is always moving. Stoves and radiators in rooms help to set the air moving indoors.

Moving air helps to keep your houses well ventilated. You open the windows to let outdoor air come in and indoor air go out. Which air would be heavier in winter?

WHAT WINDS DO

Winds do both good and harm. Let us see how this can be. Hard winds have such force that they often blow away soil, crops, forests, and buildings. In case of a forest fire, a strong wind is a great danger. We should be very careful about fire near a forest. We need all the forests we have. It is much harder to stop a forest fire when there is a strong wind, because the wind blows it along fast. If the wind is a hot, dry one, it may harm the crops which the farmer sows.

Strong winds are sometimes dangerous for ships at sea. They cause great waves, which blow ships about the sea and sometimes wreck them. Many ships have been damaged in high seas because of strong winds. Have you ever been on a ship in a storm?

But now let us look at the other side of the picture. Winds do a great deal of good. They scatter seeds about. They move sailing ships over the water. In some cases they are used for turning windmills, which pump water.

Many fliers study the winds and use them to help in flying their ships. The captain of a big German airship once used a storm to help him in one of his trips. He

Acme

High winds are making this forest fire burn faster

kept getting the reports about the storm by radio. By using these reports he kept his ship steered in the right direction to receive the winds which would help him.

One of the best things wind does is to keep the temperature more even. If air did not move, there would be a great difference in temperature between different places. Some places would be very, very hot. Other

Acme

This ocean liner is being tossed about by the huge waves during a bad storm at sea. Some of these waves wash right over the deck of the ship

places would be very, very cold. Since air moves from cooler to warmer places, it is always cooling the hot places and warming the cold places on the earth. At the seashore there is often a cool sea breeze during the hot days and a warm land breeze during the cool nights.

When air moves very fast, we say that the wind is high. Sometimes wind blows from eighty to ninety miles an hour. It is hard to walk in a very high wind. If you are walking against it, you have to push hard to get ahead at all. If you are walking with it, you have to hold yourself back or you will be pushed too fast.

THINGS TO THINK ABOUT

1. Wind keeps the temperature more even. It helps in keeping hot places from becoming hotter. It helps to keep cold places from becoming colder. What difference does this make in the ways people live upon the earth?

2. Man uses the force of air in many ways today. He even presses it together in order to get more work done. We say he compresses it. Compressed air has even more than fifteen pounds of pressure on each square inch. Man uses compressed air for many things. How many uses can you think of for compressed air?

THINGS TO DO

1. Draw a plan showing the movements of air just over the radiator in your schoolroom.

2. Blow up a balloon. Hold your hand over the opening. Notice the force of the air as it comes out.

IV

Beyond the Earth

THE SUN'S FAMILY

OUTSIDE THE SOLAR SYSTEM

PERHAPS every one of you has at some time or other looked into the sky and asked, "What is out there?" In the daytime sky you see the sun and clouds. At night you see the moon, some of the planets, and hundreds of stars. The daytime sky is full of objects besides the sun and clouds, but you cannot see most of them because the light from the sun is so bright that it hides them from sight.

The night sky is full of objects which we can study. The sky is so big that we cannot learn about all the objects in it; so perhaps we should try to find out as much as we can about a part of the sky. Suppose we start with the sun's family. Scientists have learned much about this family by looking through a telescope. Many objects in the sky are so far away that they can only be seen through telescopes.

THE PICTURE ON PAGE 143 IS FROM A PAINTING BY BEN STAHL.

The Sun's Family

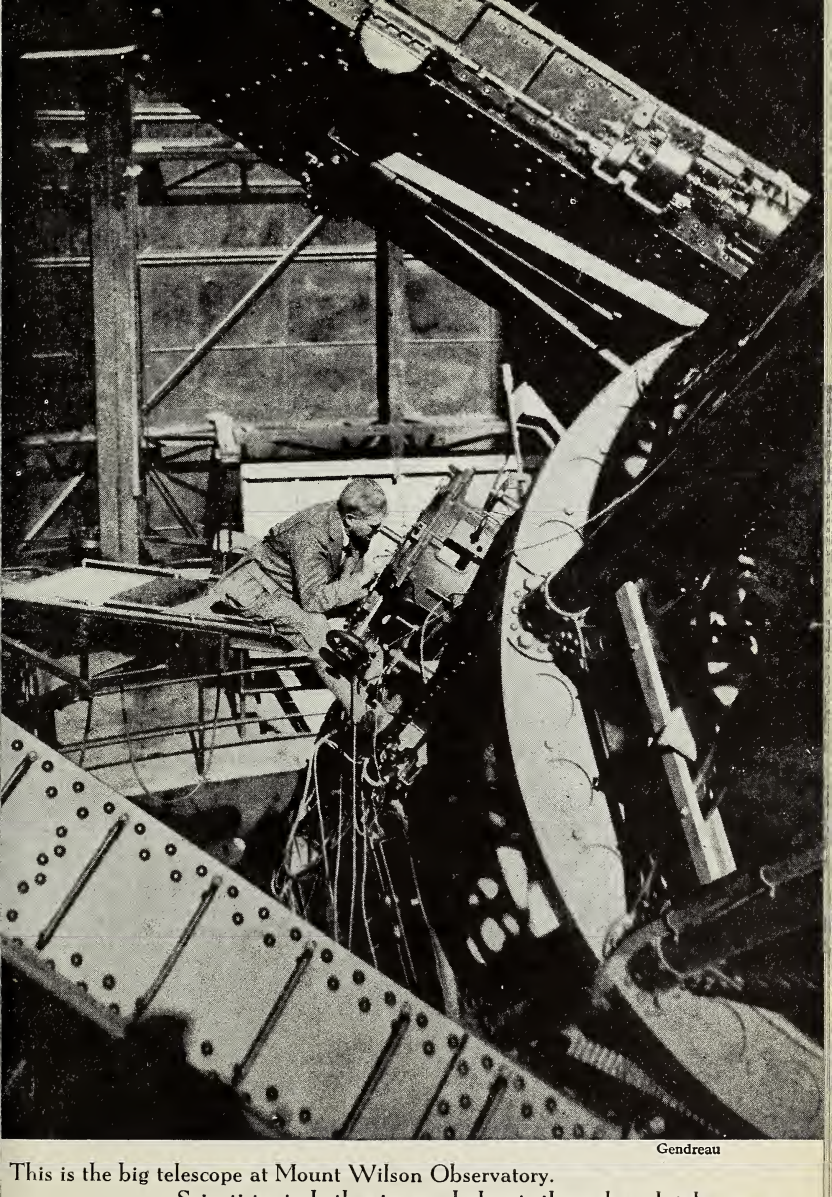
The sun is not new to you. Since you were born you have known it to rise in the eastern sky in the morning, to shine upon you during the day, and to set in the western sky in the evening.

The sun is the most important star in our sky, because it gives us both heat and light. The other stars in the sky give heat and light, too; but they are so much farther away from us that they give us very little.

The sun has a family. We call the sun's family the solar system. The sun is the only star in the solar system.

You know a good deal about one of the sun's family, because you live upon it. The earth is one of the planets which belongs to the sun's family. There are eight other known planets. All of them belong to the sun's family. There may be more than nine planets, but only nine have been discovered.

If you look at the picture on page 149 you will see the planets which belong to the sun's family. Each planet travels around the sun in a path. Each planet stays in its own path as it revolves around the sun. One trip around the sun makes one year for that planet. It takes the earth 365¼ days to make its trip around the sun; so the earth's year is 365¼ days long. Some planets have a shorter year, because they do not have so long a trip to make. Other planets have a longer year, because they have a longer journey to make. Look at the picture



Gendreau

This is the big telescope at Mount Wilson Observatory.
Scientists study the stars and planets through such telescopes

again and find out which planet has the shortest year. Which planet has the longest year?

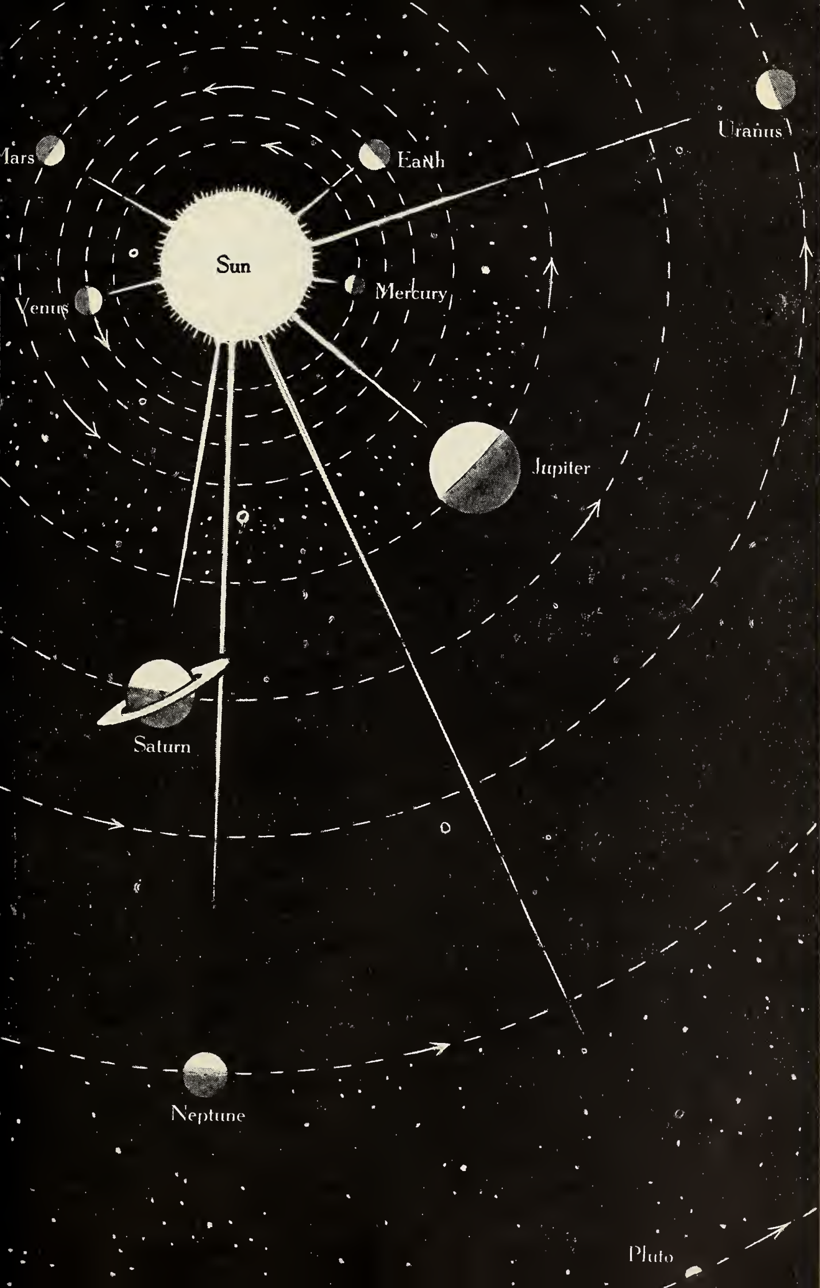
The planet nearest the sun is Mercury. Once every 88 days it makes a complete journey around the sun. So a year on Mercury is only 88 days long. Mercury has four years while the earth is having one year. If you lived on Mercury, you would have a birthday often. Should you not grow old fast? How old should you be right now if you lived there?

Scientists believe that Mercury always shows the same side to the sun, just as our moon always shows the same side to the earth. The side of Mercury which is turned to the sun must be very hot, especially as that planet is so near the sun. Mercury is the smallest of all the planets. It is less than half the size of the earth. You cannot always see Mercury in the sky. If you want to see it, look for it just before sunrise or just after sunset. It rises and sets early, because it is so near the sun.

Next beyond Mercury is the planet Venus. It is much larger than Mercury. Sometimes it is called the earth's twin, because it is about the same size as the earth. A year on Venus is 225 days long.

Venus is one of the brightest objects in the sky. It is a beautiful planet. At times it can be seen just after sunset in the western sky; at other times it can be seen just before sunrise in the eastern sky.

The earth is the next planet from the sun in the solar system. It revolves about the sun in about 365 days. In size it is like Venus. We think of the earth as one of


Uranus
Mars
Earth
Sun
Venus
Mercury
Jupiter
Saturn
Neptune
Pluto

the smaller planets. Since you live upon it instead of upon Mercury or Venus, your address might read like this:

Name.	*John Jones*
Street.	*234 Browning Avenue*
City.	*Montreal*
Country.	*Canada*
Continent.	*North America*
Planet.	*Earth*

Next after the earth comes Mars. If you find it in the sky, it will look red to you. Mars is smaller than the earth. Its year is 687 days long. If you lived on Mars, you would be only half as old as you now are on the planet earth.

Mars has been studied by many scientists. When they look at Mars through a telescope they see a good many dark lines running across the planet and white patches at the poles. Scientists have also seen streaks or lines across the surface of the planet. Some scientists think there may be life upon Mars. Perhaps some day we shall know.

Out beyond Mars is Jupiter. Jupiter is the largest of the nine planets. It is about a thousand times as large as the earth.

A year on Jupiter is between 11 and 12 earth years long. It would be a very long time from one birthday to another there.

Venus sometimes looks like this to us

Yerkes Observatory

Saturn is the next planet beyond Jupiter. It is next to Jupiter in size. One year on Saturn is about 30 earth years long. If you look at Saturn through a telescope, you will see that it has rings, or bands, around it. These rings are beautiful to see.

Uranus is out beyond Saturn. It travels around the sun in 84 earth years. Unless you have very good eyes, you probably cannot see Uranus without a telescope, because it is so far away from the earth.

Next comes Neptune. Its year is equal to 165 of our years. Neptune is so far away that very little is known about it. It can be seen only through a telescope.

The ninth planet is Pluto. It has been known to us only for a very few years. It was discovered and named in 1930. Its year is at least 248 earth years long. Pluto is so far away from us that very little is known about it.

Some of the planets of the sun's family have moons that travel around them as they revolve about the sun. The earth has one moon. Mars has two. Jupiter has several. Four of Jupiter's moons are very large. Saturn has nine moons. Uranus has four, and Neptune has only one. All the moons of the planets are part of the sun's family, too.

We do not know whether there are more planets in the sun's family or not. At this time only nine have been discovered.

Mars seems to have lines and patches on it

Slipher, from Lowell Observatory

THINGS TO THINK ABOUT

The sun's family is only one of the great groups of objects in the sky. There may be other solar systems which we know nothing about. Our solar system has one star, which is our sun, and nine planets. The nine planets differ from stars. Planets receive their light and heat from the sun; but stars have light and heat of their own.

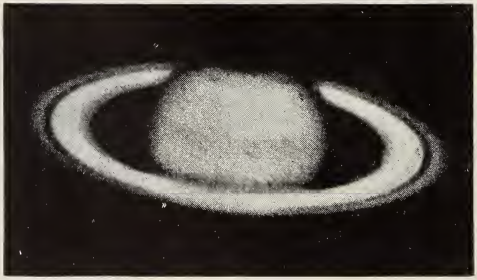
THINGS TO DO

1. Make a model of the solar system. Use clay for the sun and planets. Be sure you make the clay models so that the sun is the largest. Then Jupiter and Saturn are next largest. The earth and Venus are twins. Which planet is smallest? Place your models on a table which has been covered with paper. Place the sun near the center. Arrange the planets around the sun. Draw the paths of the planets on the paper.

2. Study the evening sky. If you have a pair of field glasses, they will help you. The moon is interesting to study through these glasses. Learn to find the North Star and the Big Dipper. Try to see some of the planets.

Many people think Saturn is the most beautiful planet in the sun's family. Do you know why?

Yerkes Observatory



Outside the Solar System

You have just finished reading about the sun's family. It is a part of the universe which we see when we look into the sky. There are thousands of other objects to study in the universe.

One scientist says there are more stars in the universe than there are grains of sand on all the seashores of the earth. Just think how many that would be. Should you like to have to count them?

Yet the universe is really quite empty in spite of all these stars. The universe goes on and on. You would have to travel millions of miles to go from one planet to another. You would travel much farther to go from one star to another. That is why we say the universe is really quite empty. One person has said that the universe is about as full as a big railroad station would be with two or three specks of dust in it.

On a very clear night the sky seems full of stars. They seem small and close together because they are so far away. You see about three thousand stars on a clear night. Yet for every one of these stars there are millions more which your eyes alone cannot see.

We do not know whether there are other solar systems besides our own in the universe. We know there are millions of stars, or suns. We know that some of those suns are much larger than our sun. But we do not know whether any of them have planets revolving around them as our sun has.

Mount Wilson Observatory

Have you ever seen the night sky when it looked like this?
This is one of the many star groups in the sky

THINGS TO THINK ABOUT

Our solar system may be only one of many in the sky. Some of the many stars you see may be suns of other solar systems. These stars are really very, very far apart. They just look close together because they are so far away from the earth. When you stop to think that some of the dim stars that you see are much larger than our sun, you will know that they must be a great deal farther away from us than our sun is.

THINGS TO DO

1. There are many stars in the sky that have names. They are parts of groups of stars. The groups too have names. There are stories that have come down from olden times about certain stars and groups of stars. Perhaps you have books in your library with some of these stories in them. If you have, you may want to read about how people of olden times happened to name some of the stars and star groups.

2. Are these sentences true?

The universe is quite empty.
There are millions of suns in the sky.
Our sun is the largest star in the universe.
There may be other solar systems in the universe.

V

Animals Which Live Together

MAN IS A SOCIAL ANIMAL

OTHER ANIMALS ARE VERY SOCIAL

HAVE you ever thought how lonely you would be if you were the only person on earth? Not only would you be lonely, but you would be so busy doing the many things which others now do for you that you would never have time to play, swim, or go on a picnic.

Men have found out that by living and working together they make life easier and pleasanter. For this reason we say that people are social. Other animals besides man live and work together, too. They have a society, or colony, which is in some ways a little like the social life which we live. We have fathers and mothers. The bees have queens and drones as mothers and fathers. They also have workers who are guards, nurses, and soldiers in their society. On the following pages you will find ways in which the social life of some animals is like the social life of people. You will find also how the social life of some animals is different from the social life of people.

THE PICTURE ON PAGE 157 IS FROM A PAINTING BY BEN STAHL.

Man Is a Social Animal

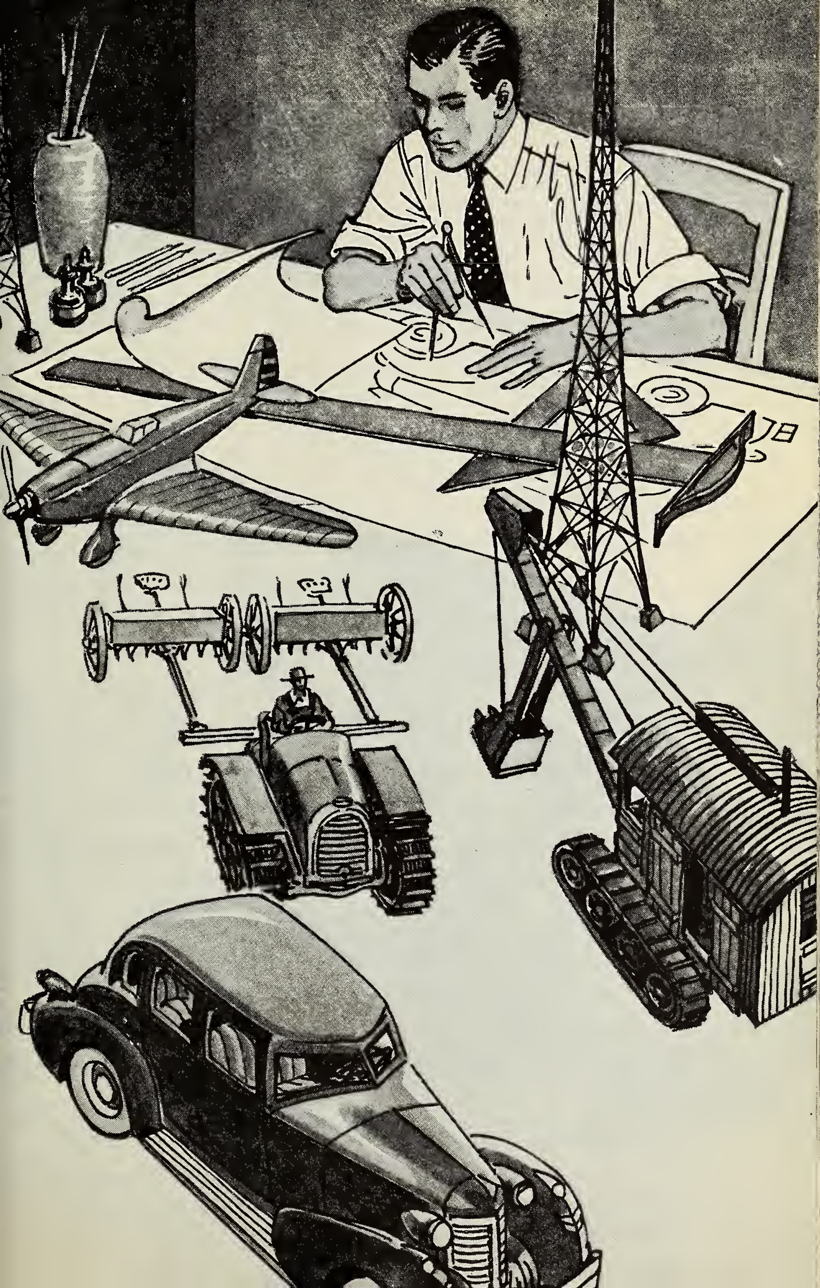
Most of the different kinds of animals in the world are social. That is, they live with other animals of their own kind for at least part of the time. Some animals are much more social than others. Some animals, such as the beavers and the honeybees, live and work together all the year round. Other animals, such as the lions and the deer, live together only at certain times of the year.

Of all the animals on the earth, man is one of the most social. From childhood to old age, human beings must live with other human beings. You need other persons, and they need you. During your childhood your mother and father help to care for you. They see that you have enough food and clothing. They see that you have the right amount of sunshine, rest, and exercise.

During your school years you meet many other children, with whom you work and play. You also meet teachers, from whom you learn much about many things. After you have graduated from high school or college, you take up some kind of work to earn a living, and again you meet persons who are helpful to you in some way or other.

All through life you come to know more and more people—at home, in school, in business, in clubs; with these people you live, study, work, or play. You would find it hard to live without other people.

It is a fine thing that man is so social. Great changes have been made because men can and will work with



others. Inventions, such as the telephone, the radio, the steam engine, and hundreds of others, have come about because men live and work together.

Although some other animals are very social, man is the only animal that can improve his life by reasoning out his problems. Each worker bee, each queen ant, each father beaver always does the same job in much the same way. The lower animals are not able to reason as man does.

As you can see, if no one ever wants to find a better way to live and to do things, there will not be any great change. But man does want better ways of living and of doing his work. He wants to try out new ideas.

Luther Burbank got an idea that he could improve potatoes. So he set to work experimenting. He was so successful with his experiments that he did not stop with potatoes, but kept on improving other kinds of plants.

A little more than fifty years ago Thomas A. Edison had an idea that an electric light could be made; so he set to work experimenting, and he made one.

The Wright brothers thought they could build an airplane that would fly, and they did build one.

So it goes. As men go on living upon this earth, they keep on discovering and inventing and changing things. Ask your grandfather to tell you about some of the changes which have been made since he was a boy. You will perhaps be surprised at many of the stories he will tell you.

As man has changed his ways of doing things, he has

Robinson Crusoe and Friday lived on a lonely island.
They had to do everything for themselves

come to depend more upon his fellow men. Early man had to do almost everything for himself. He built his own shelter, hunted and fished for his food, used the skins of other animals for clothing, and asked little of other men.

Robinson Crusoe was an interesting man in a story. He was shipwrecked. He and his man Friday lived alone on an island. He had to be very independent. That is, he had to do everything for himself. He got his own food, built his own house, and made his own clothes. He was grocer, cook, and carpenter all in one. We speak of this part of his life as solitary. By *solitary* we mean "being or living alone."

Just think how different your life is from Robinson Crusoe's. You depend upon so many people for your happiness. The milkman brings you milk. The grocer brings most of your food. The baker bakes your bread. The paper boy leaves the paper at your door.

Life today is good in many ways. But you must not forget that it makes you depend more upon others. You must be able to work well with other people.

As you read about the social animals, keep comparing them with man's society. Remember that man has the advantage, or is better off, because of his power to reason.

THINGS TO THINK ABOUT

1. Have you ever thought much about ways you work with other people? By working together, two boys can row a boat more easily than either of them could if he worked

U S
MAI

alone. Many men working together can build a good road in much less time than a few could. When you are ill, your father, mother, doctor, and nurse all work together to make you well again. Many things are done when people work together that would not be done if each one of us worked alone.

2. A boy on Clay Street had measles. A red sign was tacked on the front door of the boy's house. The city doctor put the sign there. How did this help to keep the city free from disease?

3. In Betty's school the children made some health rules together. They wanted to help one another to keep well. The rules were

Do not come to school when you have a cold.

Hold a handkerchief over your mouth and nose when you cough or sneeze.

Keep your hands away from your mouth.

What do you think of these rules?

THINGS TO DO

1. Make a list of all the ways in which a city protects the people who live in it.

2. Make a list of the ways in which people who live in the country help one another.

Other Animals Are Very Social

SOME BEES ARE SOCIAL

If you can watch insects at work and read about them in books, you will learn many things about them. It is a fine thing to rent or buy for your schoolroom an observation honeybee hive with glass sides. Then you can see honeybees at work.

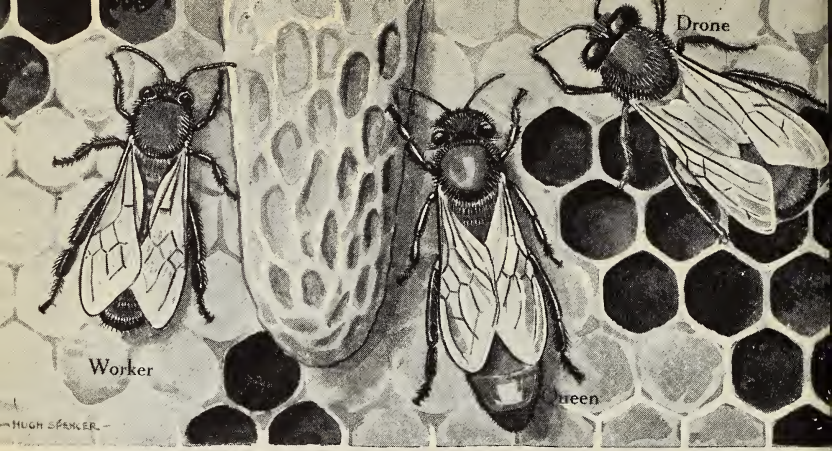
A honeybee hive is a busy place. There are many kinds of work going on inside. Let us read about life inside a honeybee hive.

All the honeybees in the hive are not the same size. There is one long, light-colored bee. This one is the queen. There are several fat, fuzzy fellows. They are the drones. All the rest of the bees in the hive are called worker bees.

All these honeybees have bodies that are alike in some ways. Their bodies have three main parts, and they all have six legs. Bees are insects. All insects have three main body parts and six legs.

The queen is the egg-layer of the hive. She backs into six-sided wax cells and lays eggs. When she comes out, worker bees close the cells with wax. Day after day during the laying season in the early summer, the queen keeps busy at her work. And her work is laying eggs. Some queens lay as many as four thousand eggs a day.

The queen does not often leave the hive. Before she lays any eggs, she goes on her wedding trip. This trip



These three kinds of honeybees live together in the hive

is a flight up into the air. The drones of her hive and of other hives fly after her. One drone mates with the queen. After this, the queen's eggs are fertile. That is, they can hatch into bees if they are well cared for.

A queen honeybee leaves her hive again when the hive swarms. She may have laid a few eggs in very large cells. The eggs in these larger cells hatch into bees which become young queens. Now a hive usually has only one queen at a time; so the old queen leaves. She may leave either before or after the new queen hatches. When she leaves, she takes some of the workers with her. This moving of bees is called swarming. The rest of the workers stay with the new queen.

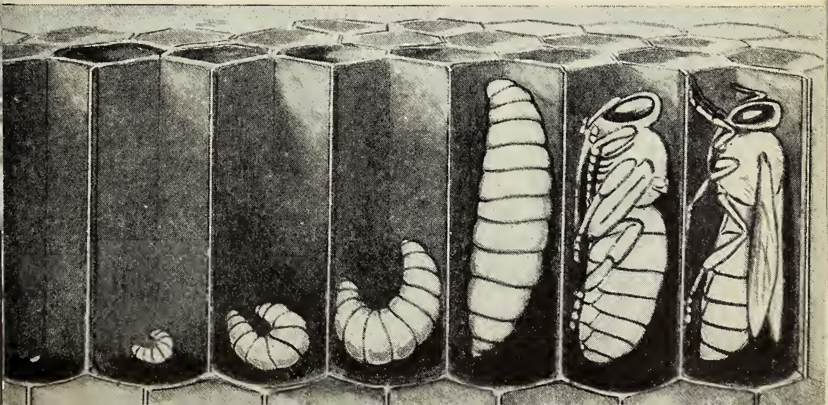
It is very important for honeybees to swarm, because more families are then formed. Whenever a hive swarms, there are two families where there was but one before.

The bees when swarming fly very close together. The swarm looks like a small, black, buzzing cloud. The bees often light upon a branch of a tree or upon a fence post.

Of course the beekeeper does not want to lose his honeybees; so he watches the swarm carefully. He puts an empty beehive near the swarm, so that the bees will use it for their new home. The queen must enter the new hive. A swarm of bees will not stay unless the queen stays, too.

The workers do many jobs. Sometimes they act as guards to the queen. Sometimes they nurse the young bees. Other times the workers fly to and from flowers gathering sweet juice called nectar and yellow dust called pollen. They carry the nectar in their honey sacs and the pollen in the baskets on their hind legs. The nectar is stored in wax cells in the hive. It is fanned by workers and turns into honey. The pollen is made into beebread and used as food by all except the young

Inside the cell things are happening



Galloway

Swarming honeybees often come to rest on trees. They have left their old hive and are on their way to a new home

queen. She eats nothing but royal jelly, a treat made only for her.

Some workers gather nectar. Others stay at home and work to make wax. They make cells from the wax and store honey in these cells. This honey is later used for food. Other workers keep the hive clean. Still others fan the air with their wings to keep the hive well aired.

One worker does several different jobs in its short life. It acts as nurse when it is young. Later on it may gather nectar and pollen. In the winter this same worker may ventilate the hive.

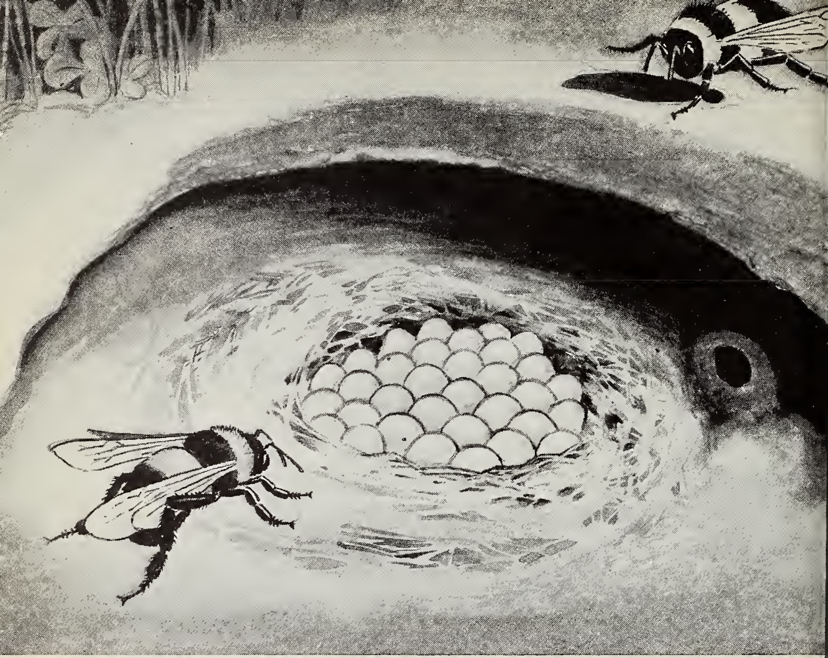
Such is the life inside a hive. And every bee does its work well. Such clockwork! The members of a bee family do not talk with one another about their work and play as the ones in your family do. A bee family does not make plans as your family does.

Bumblebees have quite a family life. The queen is the only member of the family to live through the winter. In the cold weather she sleeps in the warm, empty nest of a field mouse or a mole.

Early in the summer when the first warm days come, she starts laying eggs. She makes beebread balls for the babies to feed upon when they hatch. On each ball she lays one egg. When the young hatch, their food is ready for them.

These first bees are workers. There are large workers and small ones. As soon as they are big enough, they build the nest larger to make room for the babies which will soon hatch. The large workers gather the nectar and pollen and bring it home to make into beebread for the babies to eat. The small workers are the nurses when the babies hatch.

Man does not make homes for bumblebees; yet he is very glad to have them around. Farmers find them useful in the clover fields. These bees carry the pollen of the clover from one plant to another. The clover could



Looking into the cave nest of a bumblebee

not make seeds if the pollen were not carried from plant to plant.

ANTS ARE SOCIAL

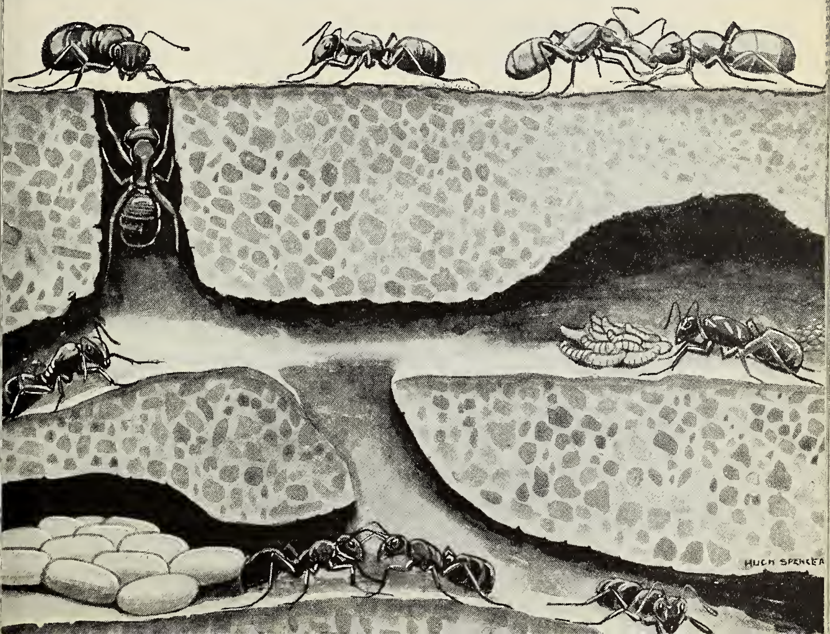
If you cannot have a beehive, you can surely have an anthill to watch. Go for a walk with your teacher. Take a large glass fruit jar and a shovel. Find an anthill and dig down deep under it. Place the dirt and ants in the jar.

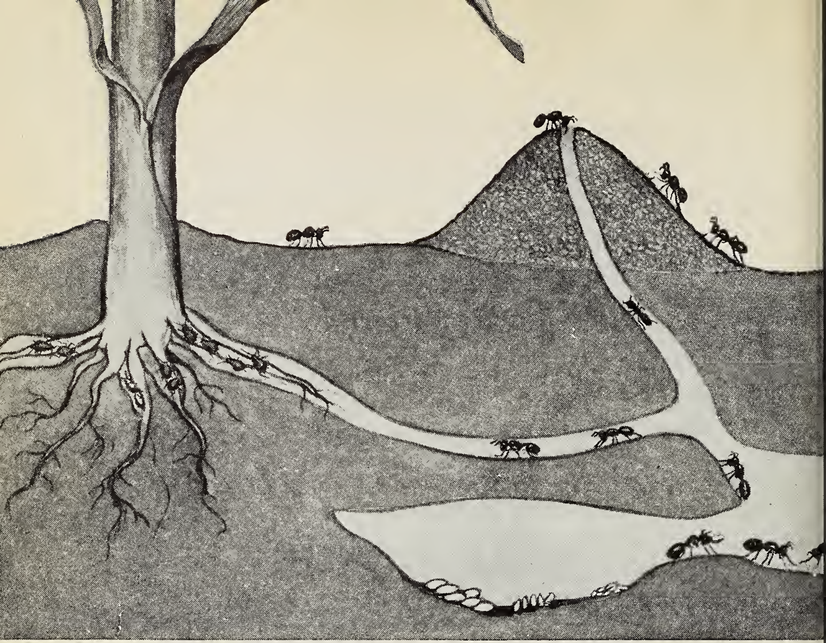
When you get back to school, set the jar in a pan of water, so that the ants cannot crawl away. If you wrap a dark paper around the jar for a few days, the ants will start working sooner. They will build tunnels along the sides of the jar. You can watch them carry the eggs, which the queen lays, from room to room. If you disturb one of their tunnels, they will build it again.

If your family of ants does not work, you may not have dug up the queen. So try another hill. By digging deeply you should get a queen.

Life in an ant family is as well-ordered as life is in a bee family. Each family has a queen, several drones, and some workers who are the nurses, housekeepers, and builders, and sometimes soldiers.

Ants build tunnels to their rooms under the ground. The queen lays her eggs in one of the deepest rooms. They are safer there





Look at the tunnel leading to the roots of the corn plant. The ants feed upon a kind of liquid which they get from the tiny aphids they find on the roots

Each ant knows just how to do his job. Each ant does his work just as other ants have done that work for centuries past.

The queen ant also takes a wedding trip. Watch carefully near the last of May or early June. On a certain day the queens from the anthills in your schoolyard will fly into the air. Each queen mates with a drone high in the air, and then flies back to earth.

Try to catch one of these queens when she lights. Put her in a glass jar. Put in some dirt. Perhaps you can see her lay some eggs in the jar.

Be sure to feed the ants you keep in the jar. A good way to do it is to place a glass funnel in the top of the jar. Put sand in the funnel. Then you can drop crumbs of bread and cake and grains of sugar on the sand. The ants will come up into the funnel to get their food. Change the sand often, to keep the food fresh. Feed the ants only every four or five days. Do not feed them much at a time.

Honeybees and ants have about the same kind of family life. They are known as very social animals, because they live together in families all the time and work for the family, not for themselves.

There are many kinds of ant families. The black ants are the ones you may find all around your neighborhood. There will be millions of them in one apartment-house hill. Their home may be called an apartment house because it is built with one story on top of another. The queen lives on the bottom floor, where she is safer.

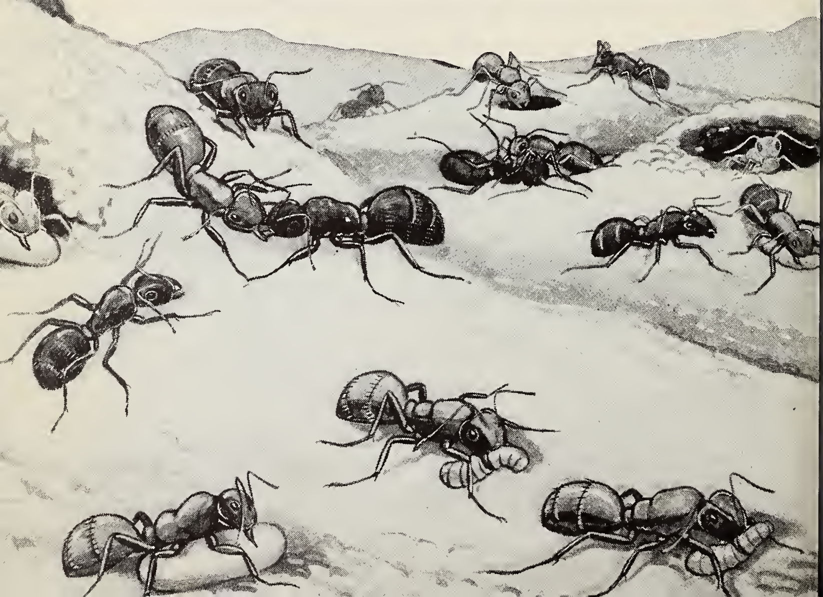
Ants often build hills near trees. Then they build tunnels to the roots of the trees. They crawl up the roots to the stems and leaves to find aphids, or plant lice. They rub the bodies of the aphids and get honeydew, or ant's milk, for food. Aphids are sometimes called ant's cows. Can you see why?

You may know about certain red ants. They are large and lazy. They capture the eggs and young of certain black ants by going into their hills. They take over the hills of these black ants and live there themselves. Young black ants may become slaves to these red ants.

There are many kinds of ants scattered about over the earth. All of them live in families and work together.

BEAVERS ARE SOCIAL ANIMALS

The beaver is a social animal. Beavers belong to the mammal family. A mammal is an animal which feeds its babies on milk from its own body. Baby beavers are born alive from the mother's body. The mother beaver feeds her babies milk from her own body. When they get teeth, they are no longer nursed by their mother. Then they eat the tender, juicy bark of young trees instead.



These warlike red ants are carrying home their treasures

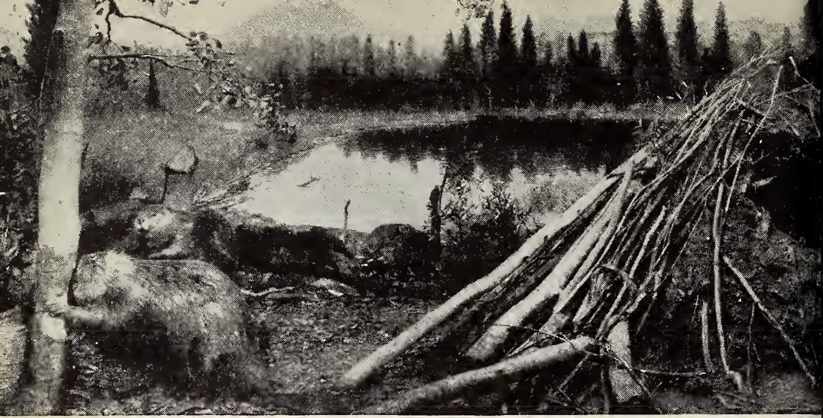
Beavers live in ponds which they make by building dams in streams. Several beaver families may live in one large pond. These beavers all work together.

The grown-up beavers work together to build their dam. Their pond must be deep enough not to freeze all the way to the bottom in winter. So they dam the stream by using poles, sticks, and mud. Several families may help to build the dam and repair it when it breaks. These families use the pond together, but each family lives in its own lodge.

Mother and father beaver work together to build a lodge, or home, in the pond or on the bank of it. The lodges are built of sticks and mud. Each lodge has two stories. The upstairs is the dry part, and the downstairs is the drying-off part. The doors of beaver lodges are underneath the water. Beavers are very clumsy out of water, but very skillful in water. They can swim out of danger from the fox, hawk, bear, or wolf.

Grown-up beavers in the beaver pond often build canals, or ditches, in different directions away from the main pond. They use the canals to float logs to the main pond. The bark of these logs is their food, and they store some of it near their lodges for their winter food. Beavers use the canals in times of danger. They can swim along in them much faster than they could travel on land. In this way they can keep away from the animals that harm them.

The mother and father work together to raise the babies. The slapping of their broad beaver tails on the



American Museum of Natural History

Gnaw, gnaw, gnaw! The beaver can fell trees with its sharp, cutting teeth

water tells the babies that danger is near. When the babies are about a year old, they may leave the pond. By that time they know how to take care of themselves.

Many beavers may work together to build dams in streams and ponds. See how they lay the sticks crisscross

United States Bureau of Biological Survey

hese beaver canals are used to float large branches and twigs to the beaver ponds. In case of danger, beavers swim home safely[1]

SOME WASPS ARE SOCIAL

Wasps are insects. Many of them live and work together much as bees do. They live in colonies.

Each hive of paper wasps has a queen, who lays the eggs. The queen lives over the winter. In the spring she raises a new family. The workers hatch first. While they are little, the queen takes care of them. As soon as they are grown, they do a great deal of work.

The nests of paper wasps, or yellow jackets and hornets, are very interesting. The paperlike material of the nests is made by mixing bits of wood with the liquid in the wasps' mouths. The outside of the nest is waterproof. Inside are rows and rows of cells. At the bottom of the nest is the opening, or door, of the nest.

[1] From *In Beaver World,* by Enos A. Mills, by permission of Houghton Mifflin Company.

Hugh Spencer

Paper wasps build a home like this

In the late fall after a hard frost, try to find an empty wasps' nest. You can learn many things from it. Wasps are our oldest papermakers. Pull off bits of the outside of the nest. It is the paper made by wasps. See if it is waterproof. Compare it with the paper you use at school. Is it as strong? Does it feel the same?

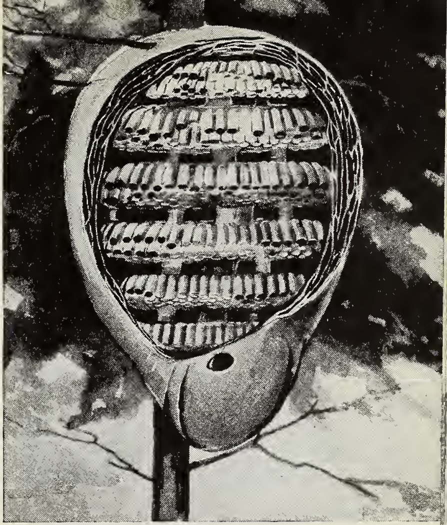
Cut the nest in two. Notice how the cells open. How do you think the baby wasps stay in these cells without falling out?

TERMITES ARE SOCIAL

There is an insect called a termite. This insect has sometimes been called a white ant. Termites are not ants. Until recently termites lived in tropical climates. They are spreading rapidly from warmer places to cooler ones. Perhaps they have already come to your part of the country. You do not welcome them, because of the harm they do. They eat their way through the wood in houses and cause the houses to fall down. Termites harm many buildings in this way. They bore into the timbers and eat parts of them away. The timbers become weak and cannot hold the weight of the building.

Termites have ruined libraries too. They have found their way to thousands of books on library shelves. It does not take long for termites to destroy books.

In many parts of the land where termites are found, builders are making houses of concrete and stone. Termites cannot bore their way into these materials.



Inside a paper wasps' nest are rows and rows of cells

Termites live in colonies, too. Some of them build large mounds. Others build hard towers, which are sometimes ten to eighteen feet high. Still other colonies have nests under the ground. These colonies are the ones that are now causing so much damage in cooler climates.

The worker termites do the damage. They are small grayish-white insects. From their deep nest in the ground they build tunnels. They often tunnel a long way under the ground to search for food. This food is wood. Floor boards, beams, sills, doorsteps, and porches of houses are often attacked.

The termites enter the wood and eat their way inside. A thin outside wall of the wood is left, while the inside becomes only a weak shell. Since they keep so much out

United States Bureau of Entomology and Plant Quarantine

Termites have been at work here eating away at these boards

of sight while they work, we often do not know that they are at work destroying our homes until much damage has been done.

Builders today are trying to keep new buildings from becoming full of termites. They are putting poisons into the soil around the buildings and into the timbers that they use, so that the termites will be destroyed.

Old buildings should be examined by men who are experts in finding termites. If termites are at work, they should be destroyed before they do much damage.

THINGS TO THINK ABOUT

1. Sometimes you hear people say that beavers are able to think. Many interesting stories which are supposed to be true are told about beavers. Scientists tell us that beavers are not so clever as these storytellers would have us believe. It is true that they live a very social life and that they work together well. But they do not plan and reason as we do, although they may seem to do so.

2. There are advantages in social life. The ants in your observation hill have a comfortable home, good food, and a clean house because they work together to get it. No one ant could do all this work alone.

3. Your life too is a social life. You depend upon other people for many things. Ask yourself these questions:

Suppose that I suddenly had to do everything for myself. Could I?

What would happen in cities if people there had to live by themselves?

Is it a good thing that man is so social?

Do you think there was ever a time when people lived alone?

THINGS TO DO

1. Write a story about the life of a queen honeybee. Be sure to tell about all the ways the worker bees help her.

2. Keep watch for a dead bee. When you get one, look at it under a microscope. Look for these things:

sting
tongue
eyes
pollen baskets
wings

Draw pictures of the way these things look to you under a microscope.

3. Try to find an empty wasps' nest. Pull it apart carefully. Notice how the layers of paperlike material are put on. Look at the rows of cells. If you cut through the middle of the nest, from top to bottom, you can see the rows very well. Look carefully at the opening. Why is it at the bottom instead of the top of the nest?

4. It would be fine to watch honeybees at work. You can buy or rent an observation hive with glass sides. You can learn many things about how honeybees live and work by watching them in a hive.

VI

How Other Animals Live

SOME ANIMALS LIVE TOGETHER PART OF THE TIME

SOME ANIMALS ARE SOLITARY

THERE ARE ADVANTAGES IN BOTH WAYS OF LIVING

YOU have been reading about some of the animals that live together all of the year. We think of these animals as very social. They work together to build their homes. They gather food for one another. In times of danger they help to keep one another safe. They work together to raise a family.

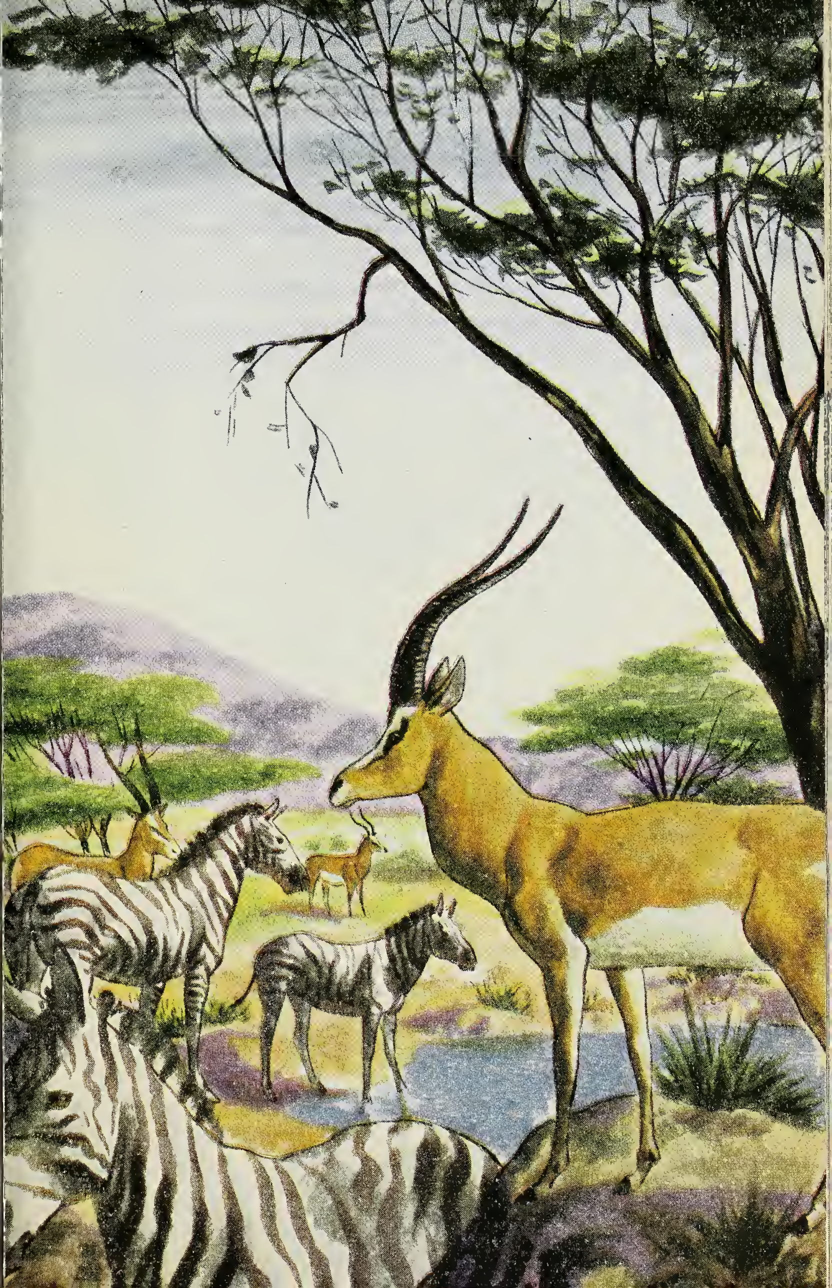
Some animals are less social. They live together only part of the time. The rest of the time they live apart. Let us find out about some of these animals.

The animals that live apart most of the time are called solitary animals.

In what ways do you think social animals might get along better than solitary animals?

In what ways do you think solitary animals might get along better than social animals?

THE PICTURE ON PAGE 187 IS FROM A PAINTING BY BEN STAHL.



Some Animals Live Together Part of the Time

ANIMALS THAT BAND TOGETHER FOR PROTECTION

Some animals do not live in families. They live together only at certain times of the year. They are not like the family animals, because they do not build homes for their young. They don't take much care of their babies after they are born. And they do not teach them to catch their food.

Some of these animals travel in herds. They can leave the herd at any time they wish and they can join it at any time. Often the female leaves the herd to care for her babies when they are very small.

The herd may be ruled by either a male or a female. Sometimes there are two leaders. A male leads the males, and a female leads the females. The red deer and the fallow deer form into such herds after the mating season.

The ruler must prove that he is able to lead. A battle follows. The winner is leader as long as he is strong enough. He must keep fighting for his right to be leader of the herd.

Animals in herds help to keep one another safe from danger. Herds of deer, buffaloes, and sheep are protected from wolves in this way. A herd of deer can kill a wolf; but one deer cannot do it alone.

Gendreau

This large herd of reindeer is on the march in search of food and water

Many of the animals of the colder places are found to live in herds. It is easy to see how they keep warmer by staying close together.

Did you ever notice how much warmer it is when a crowd gathers around you? This is true of animals in the north. They keep one another warm. They keep one another from getting so cold in the cold weather.

If you live where it is cold in winter, see whether animals in the zoo or the barnyard seem to stay close together. Watch a herd of cattle huddle together in the barnyard during a heavy snowstorm. They are able to keep warmer when they stay so close together. Watch them in warmer weather and see if they stay so close together.

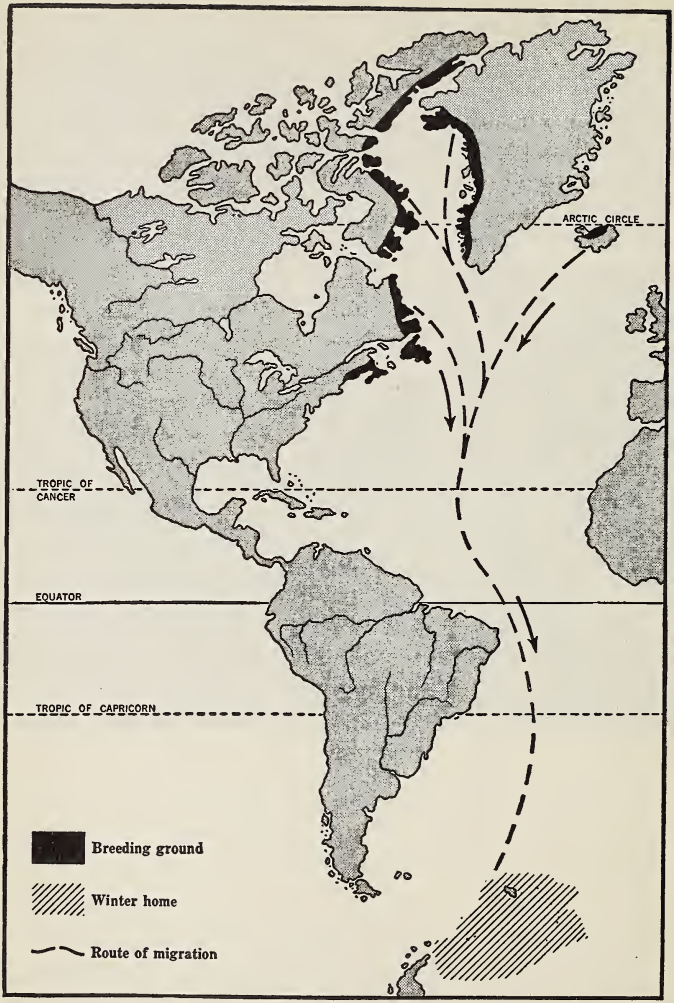
If you have ever raised a flock of turkeys, you will know how close together they get at night. They will scatter about over the field for food during the day, but at night they roost close together on the roof of a shed or on the fence. Turkeys come together at night for protection while sleeping. If an enemy comes near, a turkey will tell the others by its cry. Chickens do the same thing. They make such a fuss that they all wake up and try to escape. Chickens have many enemies who hunt at night. A cry of alarm often saves a whole flock of chickens.

Many of our birds roost together in trees or buildings for the night. A flock of partridges sleeps in a circle with heads pointing out. They help to protect one another from an enemy.

Lambert

These turkeys roost together at night. They warn one another in case of danger

Crows, robins, blackbirds, and chimney swifts band together at night to sleep. Bats often come together in caves and barns to sleep by day. During the night they fly about by themselves. Hawks often sleep together during the day. All these birds get protection in this way. Watch other birds that live near your home. Notice what ones roost together.



The arctic tern travels 11,000 miles as it migrates from the Far North to the Far South

MANY ANIMALS BAND TOGETHER TO MIGRATE

A great many kinds of birds flock together to migrate. To migrate means to move about from place to place. Birds fly north for the summer and return south for the winter. You must watch for these migration times. When school begins in the fall, many birds will be seen flocking together. There will be great numbers of them. Then as it gets colder, you will see fewer and fewer flocks. You will know that these birds have left you for their winter homes.

In the spring you will want to watch the flocks return. Some of the birds will summer in your neighborhood. Still other flocks will only fly through on their way farther north.

The spring migration is more interesting to most people than the fall migration. In the spring many birds are beautifully colored. By fall their colors have changed so that you might not know them as the same birds.

Some animals travel great distances. The bobolink travels from New York to Brazil, a distance of 2500 miles. The arctic tern travels a distance of 11,000 miles as it migrates from the Far North to the Far South.

Eels travel from Europe and North America to lay their eggs near Bermuda. They all leave the rivers and lakes where they live at about the same time. About a year later the young eels have traveled back to the rivers and lakes again.

Salmon band together to migrate. They travel up the swift streams to lay their eggs. The hardships which the salmon stand in working their way up streams are a wonder to us. After they have laid their eggs, they die.

The reindeer of the Far North migrate in herds. They go to search for new places to feed. Sometimes they travel in great herds for hundreds of miles.

Whales band together to migrate to their breeding grounds. They travel far out to sea together. Seals and sea lions migrate in much the same way.

SOME ANIMALS BAND TOGETHER TO GET FOOD

There are some animals that come together in the daytime to feed. At night they go by themselves again. Such herds are often made up of several different kinds of animals. Elk, antelope, and cattle are often seen together in a feeding herd. Zebras and gazelles also feed together in the same herd.

Some kinds of birds join for feeding. These groups often have a woodpecker as a leader. There may be nuthatches, creepers, and titmice, and woodpeckers all feeding together.

In India there is a social kind of spider. Spiders of this kind help each other in mending their nests. They share the food that is caught in their nests.

Sometimes wolves hunt together. They form in a long line. They divide into two groups. One group chases the animals to be used as food while the other

Rittase

Wild geese often are seen flying together
in this way as they migrate north and south

group blocks their path. Hyenas and jackals hunt together in much the same way.

Lions sometimes hunt with their own families. Some beat the brush, while the others jump upon the hunted animal as it runs past their hiding place.

SOME ANIMALS BAND TOGETHER TO HIBERNATE

Some animals band together to hibernate, or sleep during cold weather. Rattlesnakes sleep together in rocky places. In the spring they wake up and crawl off alone again.

Little brown bats hibernate in caves during the winter months. There are mosquitoes in Kentucky which hibernate in caves during cold weather.

Two water snakes taking a sun bath just after coming out of hibernation

Lynwood Chace

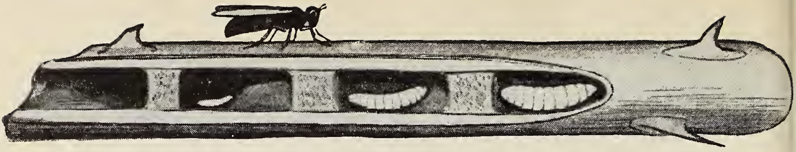
THINGS TO THINK ABOUT

Social life has several advantages for animals. It gives some animals protection. Others are able to get food more easily when they band together. Watch the animals that live near you. See if you can find out whether these animals are very social. Why do they live together? Notice how they work together.

THINGS TO DO

1. Make a list of animals that live together all the year through.

2. Make another list of animals that live together only part of the year.



If you could look inside the nest of a solitary bee, it might look like this

Some Animals Are Solitary

There are many animals that live alone most of their lives. These animals go their own way, getting food wherever they can. They have almost no family life. They live together for only a short time, while they mate. Frogs, toads, lizards, alligators, crocodiles, fish, and many insects belong to this group.

These animals are sometimes called solitary. A truly solitary animal would be one that never had anything to do with any other animal of its kind. Animals are usually social at some time in their lives. Toads and frogs cannot be said to be truly solitary, since they meet at egg-laying time. There are really no truly solitary animals.

SOME BEES ARE SOLITARY

Some bees live alone almost all the time. They come together only to mate. These bees are called solitary. They build their nests in the ground or in holes in walls, trees, or plants. They use either earth for building or a sticky gum called resin, which they get from pine trees.

The bee that lives alone almost always builds a row of cells like those you see in the picture above. In each cell she places a ball of beebread and an egg. When the young bee hatches, it eats the beebread.

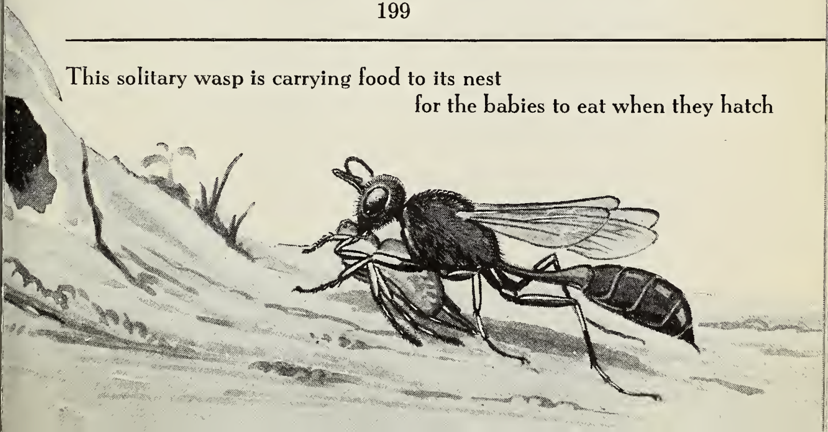
The mason bee builds its nest of clay. It fastens the nest to stones in a field. After the cells have been built, the bee gathers pollen for beebread and nectar for honey. Then she lays her eggs. She builds a thick cover over the top of the nest to protect the eggs.

SOME WASPS ARE SOLITARY

Some wasps are not social. They come together only to mate. The mud-dauber wasp is solitary. The female builds her nest of stones and mud on the ground. There are several rooms in the nest. She puts a caterpillar in each room. The female hunts the caterpillars, poisons them, and pulls them home. She lays an egg on each caterpillar and then shuts the door of each room and flies away. When the babies hatch, they have plenty of food to last them until they can hunt for themselves.

A mason wasp builds a nest like a jug. She fastens it to the branch of a tree. The door opens at the bot-

This solitary wasp is carrying food to its nest for the babies to eat when they hatch



tom. This wasp also leaves caterpillars for the babies to eat when they hatch.

The cicada-killer wasp lives alone, too. It builds a nest under the ground. The wasp puts cicadas, often called locusts, in the nest for the babies to eat when they hatch.

MOST SPIDERS ARE SOLITARY

There are many spiders scattered about over the earth. Almost all spiders are solitary. They live with others for only a very short time, while they mate. The rest of the time they live by themselves.

You know about many of these spiders. The banded spider can be seen in many places. You can tell it by its yellow, black, and silver bands. You may call it the garden spider. It is found in gardens.

This spider builds a fine, round web in which to catch its food. The web makes a good trap for insects. The spider will eat almost any insect that happens to get caught in its web.

At egg-laying time the banded spider spins a bag. She lays her eggs in it. Then she dies. The babies have to look after themselves when they hatch.

Some spiders do not use webs for catching their food. A jumping spider jumps for its food. Its eyes are sharp. After every few steps which it takes, it raises its head and looks about. When it sees a fly or a bee, it springs upon it. These spiders live alone and each hunts its own food.

Crab spiders are solitary. They hide in flowers and wait for bees or butterflies to come along. With their poisonous jaws they kill any insects that happen to come their way, and then eat them. The female sits day after day guarding her nest of eggs. In about five weeks she

No wonder this clever spider catches food in her trap

Lynwood Chace

makes a hole in the nest so that her family can get out, and then she goes away. After the babies hatch they must look out for themselves.

Most spiders are harmless to people. The ordinary spider's bite is usually not worse than a bee's sting. But there are a few families of spiders which are very poisonous to people. One such family of spiders is known as the tarantula family. Tarantulas are found in the warm parts of the world. They are very large spiders. They live in burrows, or holes, in dry, stony ground.

The female sits outside her burrow, watching for some dinner to pass by. A fat bumblebee is just right. With her sharp poisonous jaws she kills it at once.

You would not think that this hunter would be a good mother; but she is. When August comes, she spins a thick web. She lays her eggs upon it, and rolls the eggs up in the web into a small ball. She fastens the ball to her body and keeps it there until the eggs hatch.

The young spiders climb upon their mother's back and ride about wherever she goes. But later each spider lives alone and finds its own food.

One kind of spider makes a trap door at the door of its burrow, or hole. It is called the trap-door spider. The hole is almost always dug in the side of a hill. When a spider wishes to come out, it lifts the door from within. The weight of the door closes it. The spider bolts the door from the inside by placing its claws in holes in the door. There it may live by itself and be safe from its enemies.

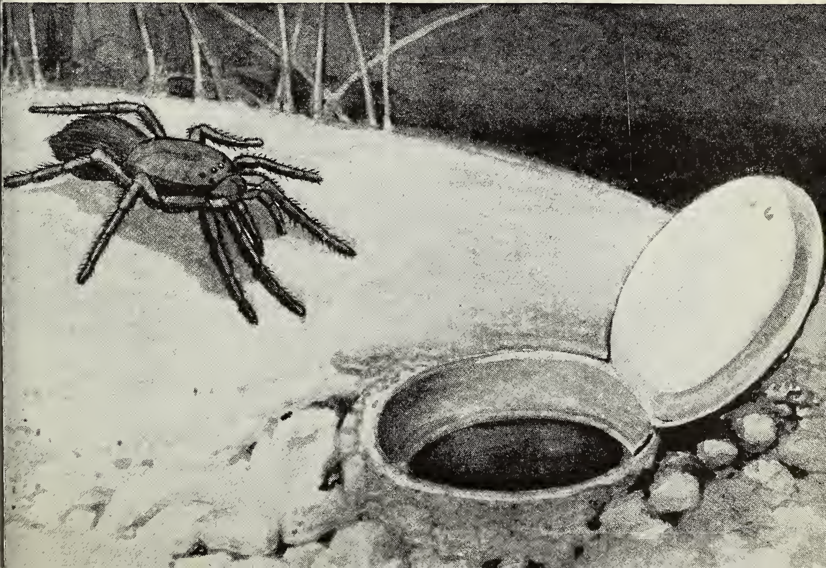
So we see that most spiders could be called solitary animals. They do not live together for food or protection. They have no real family life.

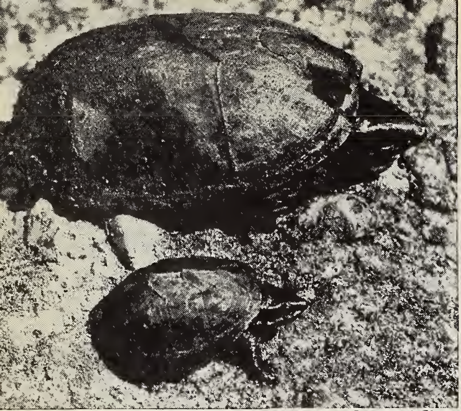
OTHER SOLITARY ANIMALS

There are some animals that are seen together not because they help one another when they are together, but for other reasons. Most butterflies feed together in gardens. They come there because of the smell of the flowers from which they get their food.

Many other insects are together because their eggs have been laid in the same place. You may have seen May flies, hundreds of them, flying together over a lake.

The nest of the trap-door spider is often built on a hill





Lynwood Chace

Two mud turtles sunning themselves on a rock

They are together only because their eggs happened to be laid on that lake.

This kind of group is quite different from a herd of deer feeding together or a hill of ants working together. Can you see that it is? The May flies are in the same place by accident. They do not stay together. They are likely to separate. The deer are together because being together protects them.

Go to a pond on a sunny day. You may see a number of turtles sunning themselves on the same board or rock which sticks out of the water. You may think that this is a flock, or school, of turtles; but that is not true. They are together only because they happened to see that place to sun themselves. Each one crawled up. When there was no more room, the ones that came late crawled on top of the early ones.

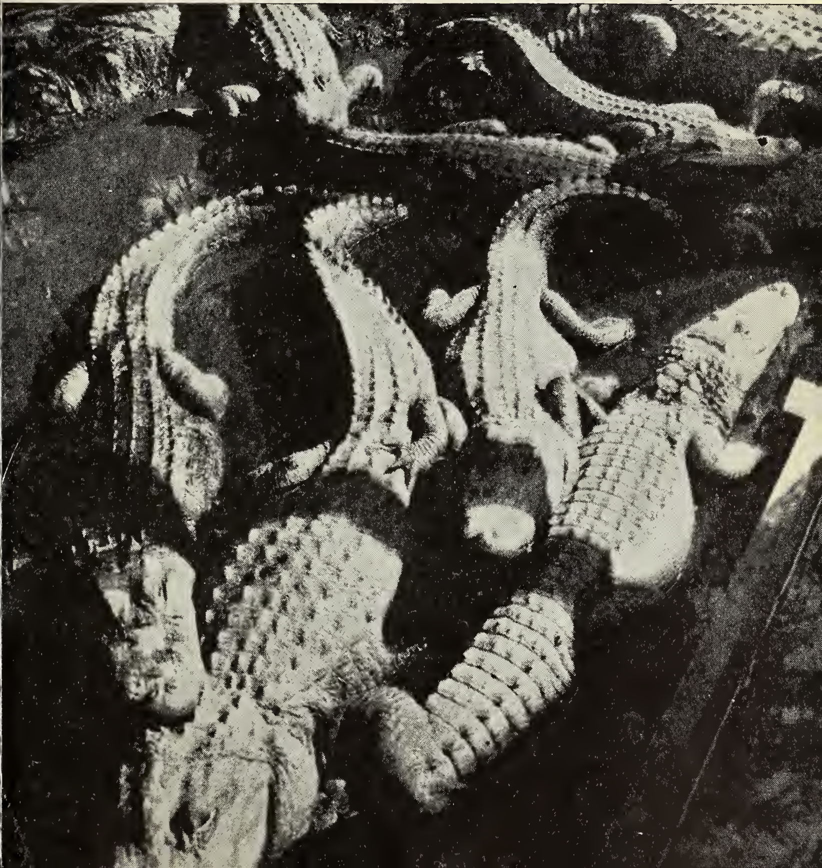
Crocodiles and alligators do the same thing. They are together because they just happen to find the same place in which to sun themselves. Snakes gather in stony places in the same way.

Frogs often sit together upon logs and pond lilies to sun themselves. Each one comes there alone, and each one leaves alone when he is ready to take a dip into the water. They do not leave in groups.

You often see pictures of animals around a water hole during the dry times of the year. They are there only to get water and just happen to be there at the same time of day to get it.

Alligators sunning themselves

Keystone



THINGS TO THINK ABOUT

1. As you think about the ways animals live and work together, you come to know that some are very social indeed and that others are not quite so social. And you know that still others are hardly social at all.

Can you name some animals that belong in each group?

2. Solitary animals have to be very independent. They must be able to get their own food, to protect themselves from danger, and to make their own homes. Do you think they have a very easy life?

3. Social animals work hard. There are so many to eat the same kinds of food that it sometimes becomes hard to get. There are so many babies to raise, too. Even though social animals work together, there is work for all to do.

THINGS TO DO

1. Catch a spider in a bottle and put it into a wire cage. Put in a fly for it to eat. Watch the spider build a web. Break some of the threads of the web and watch this busy worker mend them.

2. In the spring try to find the balloon-shaped nest of a banded spider. Bring it to school and watch the babies hatch. They will make their threadlike flying machines for you to see. Then let them go. Do they stay together?

There Are Advantages in Both Ways of Living

You have read about many animals that live a social life. You have also read about other animals that live a solitary life. Have you been wondering whether there are advantages in both ways of living?

We cannot tell whether one is better than the other. Each way has both advantages and disadvantages.

It is easier for animals to store food and protect their young when they work together. Most of the social animals eat plant food instead of meat. They work together to store their food. Many of the solitary animals hunt alone for meat. They do not store it for long because it will not keep.

When animals are very social, they are likely to become dependent upon one another. The drone bee cannot feed himself. The workers have to feed him. Some ants die if their slaves die.

Sometimes the food of animals becomes scarce. There may have been a cold time or a very dry time of the year. At these times it might be better to be a solitary animal. Social animals might use so much of one kind of food that it would become very scarce. They might have to travel a long way to get enough food to feed all of their family.

VII

The Value of Plants and Animals

HOW MAN USES PLANTS

HOW MAN USES ANIMALS

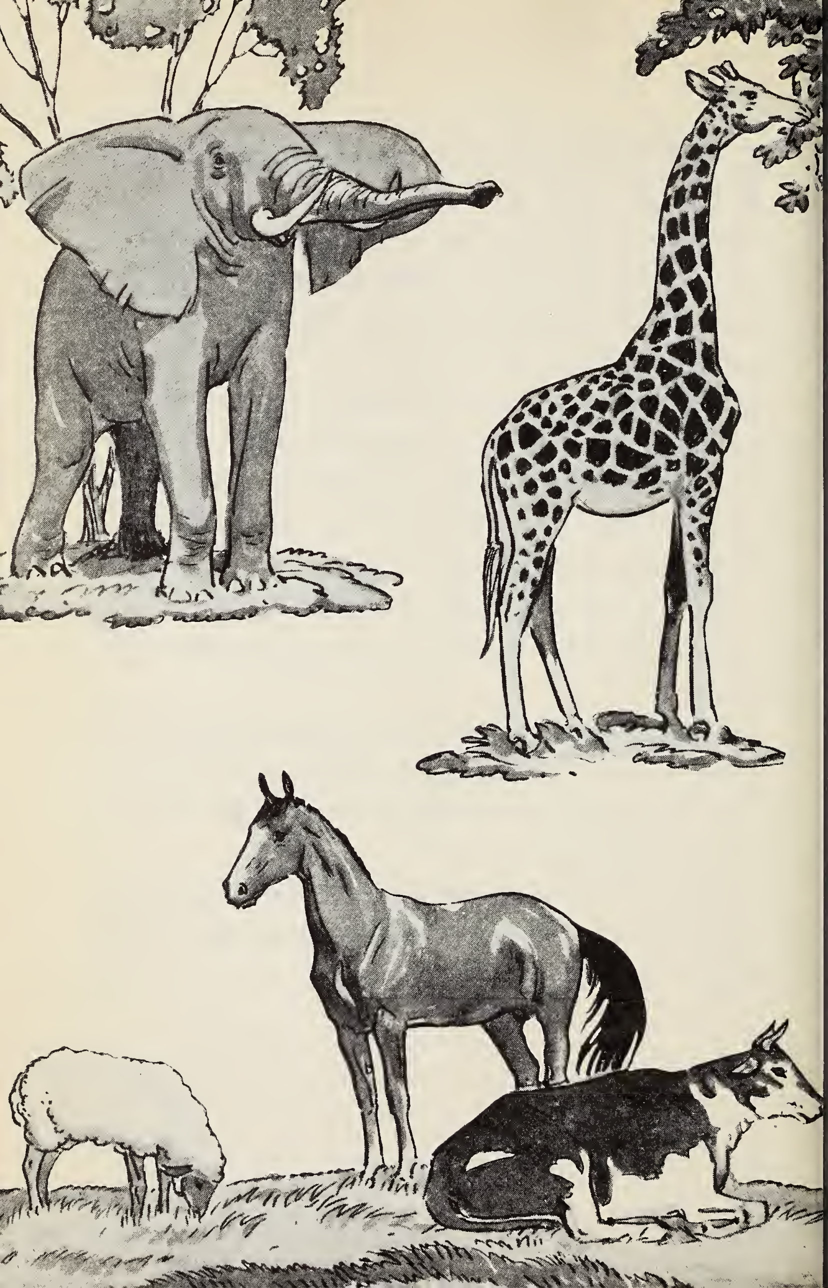
EVERY living thing upon this earth depends upon living things for its life. No plant can live independently. Each plant may be affected by the other plants that grow near it. A plant may stop growing because neighboring plants may take from it the food and water in the soil which it needs.

No animal can live independently. It may need other animals for food. Or if it depends on plants for food, the plants on which it depends may become scarce. Then the animal will starve, or it will have to move to another region where there is enough food.

Scientists say that all living things are related. This means that every living thing depends upon other living things.

Man has made changes upon this earth which have affected some of the plants and animals. Man has done some things which have been good, but he has made many mistakes, too.

Man uses both plants and animals. He depends upon them for many things. Let us read about some of the ways in which he uses them.



How Man Uses Plants

PLANTS GIVE US FOOD

Plants are very important to man. They furnish him with food. Just go to market with your mother, and you will see for yourself how very important to man plants are as food. You will see lettuce, carrots, potatoes, peas, beans, and many other fresh vegetables. There will be oranges, grapefruits, apples, and other fresh fruits. On the shelves there will be rows and rows of cans full of fruits and vegetables. All these plants are sold to your mothers and fathers and to other people for food. It takes a great many fruits and vegetables to feed all the people in the world.

Animals too depend upon plants for food. Horses, cattle, sheep, and pigs keep alive by eating grass and corn and grain which the farmer raises. Many wild animals are plant-eaters. The frisky rabbits and squirrels, as well as the large elephants and giraffes, all use plants for food.

Some animals use other animals for food. The mountain lion feeds upon the smaller animals which he finds in the forest. The tiger springs upon its animal food. You could name many birds and other animals that eat animal food.

But all animals depend finally upon plants for food. The animals that were eaten had to get their food from plants.

Galloway

Does your mother ever take you to a market like this?
These fruits and vegetables are part of the food you eat

The story might go like this:

A tiger ate a fox;
The fox ate a cat;
The cat lapped the milk
Of the old Jersey cow;
But the cow ate grass.

An eagle caught a hawk;
The hawk caught a weasel;
The weasel dined upon a chick,
Which lived in a coop;
But the chick ate corn.

Sometimes plants become scarce. Perhaps a hard winter kills a great deal of the wheat. Sometimes a late spring frost injures the fruit crop. Perhaps the summer is a very dry one, and the farmers' crops are ruined.

When any of these things happen, food is scarce. If your mother buys fruit and vegetables then, she pays a higher price for them. But many people have to go without some of these fine foods, because they have not enough money to buy them.

Animals also suffer. There are not enough fruits and grain for the birds. The squirrels and chipmunks cannot find enough nuts. Wild animals grow thin for want of food. If plants are very scarce, many animals die.

PLANTS GIVE US CLOTHES

What a nice warm suit you are wearing! Where did it come from? Of what is it made?

Your coat and trousers are made of wool. Somewhere miles away from you a sheep was robbed of her soft coat in order that you might have that suit.

But, you say, what has that to do with plants? Just this: The sheep ate the grass upon the hillsides or in the meadow. She nibbled the grass and bushes that grew there. She ate plants and grew the wool that was used in your suit.

You probably have on a cotton shirt. The material which was used in your shirt came from the cotton plant. The plant grew in some warm, sunny place upon the earth. Within the boll, or seed part of the plant, grew

Nesmith

The cotton from these fluffy bolls is used to make cloth for your clothes

some soft fluffy cotton. When the boll burst open, the cotton was picked out and sent to a factory to be made into your shirt.

And your tie! It is made of silk. This silk was woven from thread which a tiny silkworm spun for its cocoon cradle. The silkworm fed upon the leaves of the mulberry tree. The thread was spun upon a spool and later it was woven into your tie.

Oh, yes! there are your rubbers, which were made from the sticky milk of the rubber tree. And your straw hat! It was woven from the threadlike *fibers* of a plant, too.

The boys and girls who live in the very warm parts of the earth wear little clothing. Some of them wear grass skirts. Others wear loose white-cotton coverings.

No matter where you live, some of your clothes are probably made from plants. Is that not true?

Not all the cloth that is made from plants is used for clothes. Some of it is made into sheets and towels and tablecloths and napkins, which you use every day. Some of it is made into curtains and chair coverings.

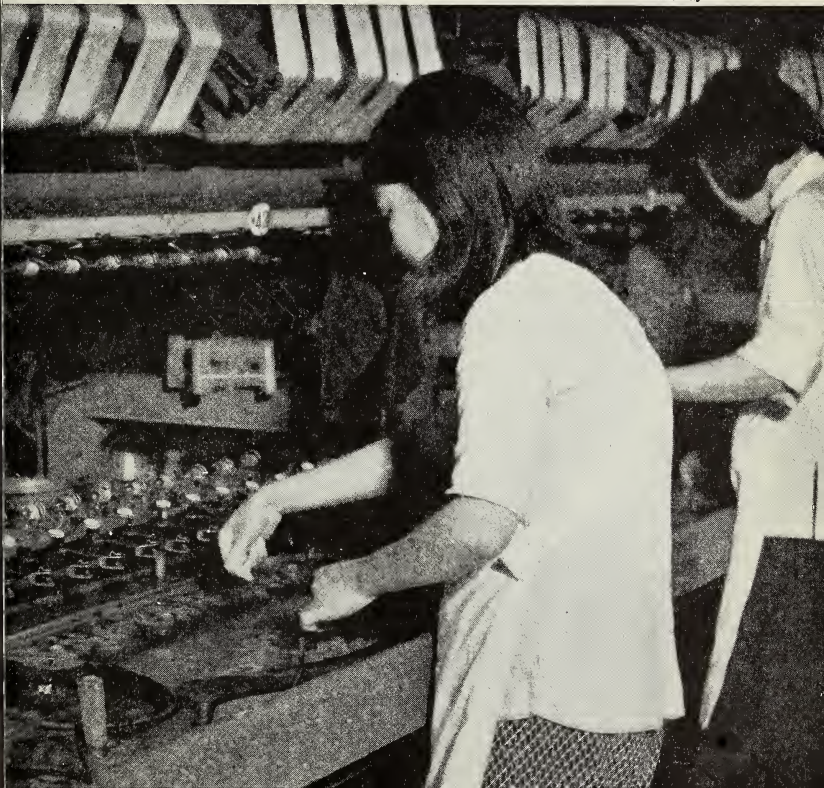
Our lives would be greatly changed if suddenly all our clothing had to be made from something besides plants.

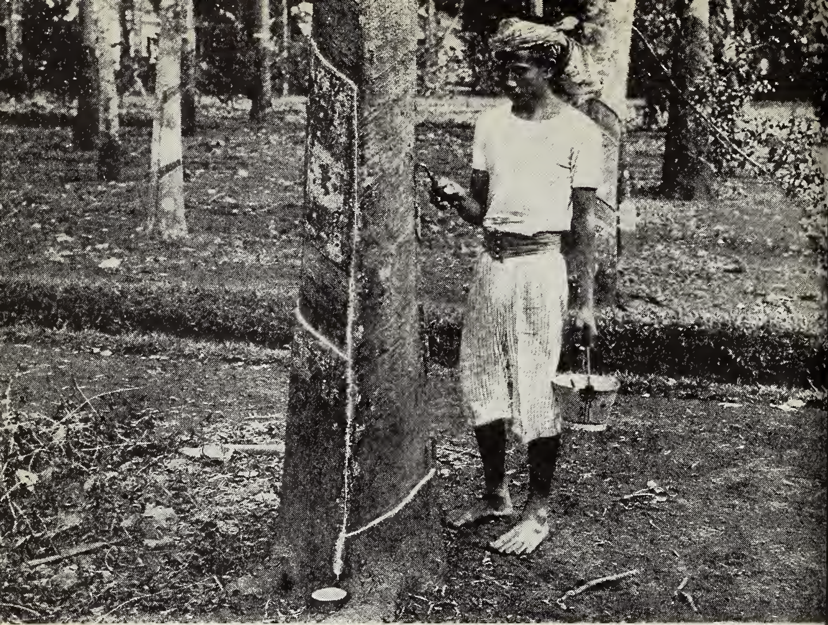
PLANTS GIVE US SHELTER

Long ago, when North America was being settled, great trees were cut down and made into homes for the pioneers.

These girls work in a silk mill in China.
They are taking the thin silk threads off the cocoons of the silkworm

Galloway





Galloway

This man is tapping a rubber tree. The sticky milk of these trees is used to make your rubber boots

We have always used plants for building houses. We do today, even though forests are not so plentiful as they once were.

The people who live in warm countries often live in coarse-cotton tents. They may live in grass and bamboo houses. In Japan, paper is used for the sides of the houses. The paper is stretched between bamboo frames.

When you go camping, you may sleep in a tent made of coarse cloth. This tent makes a fine shelter for you when you are camping out on warm summer nights. It would not be such a good shelter for cold winter days.

Much of the furniture which you have in your home is made of wood. The chairs you sit on may once have been tall trees in a forest. A maple tree may have been made into a chest for your bedroom. The wood in your kitchen table may once have been a pine tree which grew in Norway or in Maine or some other place.

If you were to travel north or south or east or west, you would find that people use plants in many ways. One of the ways that people use plants is for shelter.

PLANTS ARE USEFUL IN OTHER WAYS

Mother and Father built a new house. It was made of beautiful material. It was set way back upon a large

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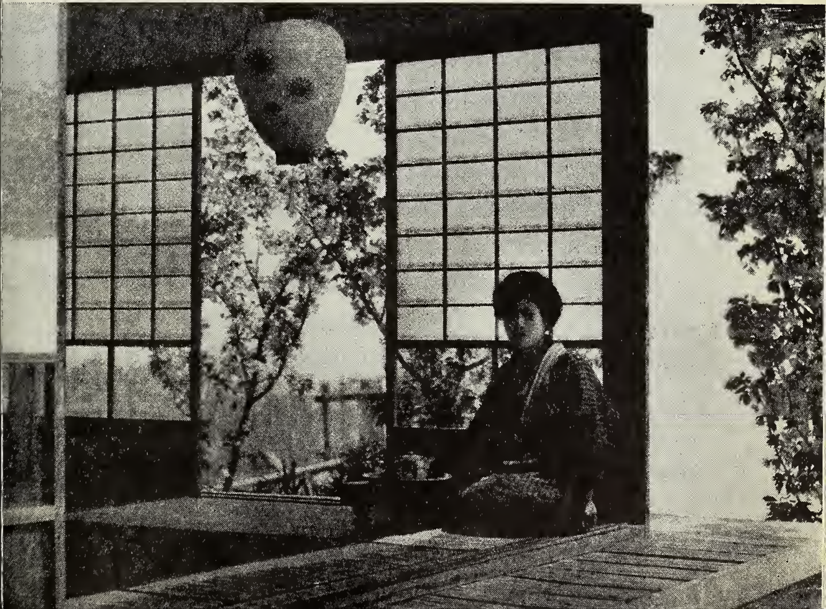
The Japanese build houses with paper panels

De Cou, from Galloway



lot. It was painted white. But there was something wrong with it. It did not really look right. There was something missing.

Of course it did not take them long to discover what the trouble was. There was no lovely green lawn; there were no shrubs, no shade trees, no flowers about. How bare it looked!

They set to work to make their new house look more homelike. Shrubs were planted. Flower beds were made. The yard was planted with grass seed.

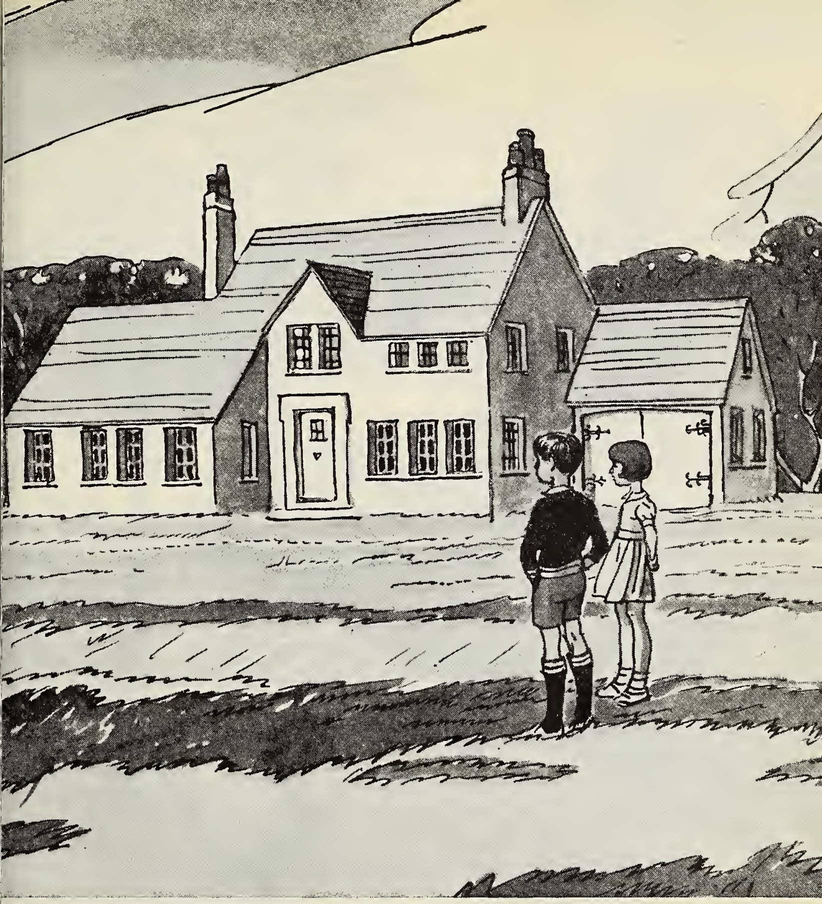
What a difference there was a year from then! The lawn was a bright green. The shrubs were white and green. The yellow daffodils seemed to be trying to look better than the bed of yellow and red tulips.

"Plants make all the difference in the world," they said.

Plants are useful in other ways too. Think of all the ways in which people use paper. You use it to write upon in school and at home. Men use it for printing the news which your father and mother read in the daily newspaper. The storekeeper uses it to wrap up packages. Printers use it in making thousands of copies of books each year.

Paper is made from plants. Sometimes wood is used for papermaking. Sometimes paper is made of straw and rags. Most of the paper which you use at school is made from wood.

Man uses plants for making dyes. Some of the most beautiful colors ever made come from vegetable dyes.



This is a new house. There is something missing. Can you tell what it is?

The Indians learned how to make beautiful colors. They dyed their wool and wove it into fine blankets and rugs.

Other kinds of dyes are used today. The Indians use them, too. But they never get such lovely clear colors as they did when they made their own dyes.

Here is the same house. The grounds have been planted with trees and other plants. How different the house looks now

THINGS TO THINK ABOUT

1. Plants are really very useful to us. You have learned that they are used as food for growth and health. You know that your linen dress and hat are made from plants.

Farmers know that plants hold the soil to the earth and help to prevent floods. Can you think of other ways in which plants are useful to us?

2. North America was once covered with forests and grassland. As man moved westward he cut down many of these forests, plowed the grasslands, and turned the land into farmland. Some of the land which had raised good forests did not raise good farm crops. What do you think should be done about it? Do you know whether anything is being done to bring back the forests in your neighborhood?

THINGS TO DO

1. Make a list of all the clothes you are wearing which were made from parts of plants.

2. Make a list of all the ways in which plants are used in your schoolroom. Do not forget your books, tablets, and pencils.

3. Try to make some dye out of berries and roots. Dye some cloth in it. If you need clothing dyed for a play costume, you may want to use some of your homemade dye for it.

4. Try this experiment to help you to see what plants do: Prepare two boxes of soil. Plant one with grass seed. Do not plant anything in the other box. Place them outside on the window sill. Give each the same amount of water. Let the grass grow. Then look to see which holds the moisture longest. Did you discover that plants help soil to hold moisture? Now place the two boxes in a strong wind. Watch to see which box loses the more soil.

How Man Uses Animals

MAN USES ANIMALS FOR FOOD

You have just read of the many ways in which man uses plants. You have found that one of these ways is to use plants as food. But man uses animals for food, too.

Many of the foods you eat every day are animal foods. Meat, cheese, eggs, butter, milk, and honey are all animal products.

It would be hard to think of a day in your life when you used none of these foods. Each one of them is good for you.

Milk gives you calcium, which helps to make your bones and teeth strong. Butter, cheese, cream, and meat furnish fat for you. Fat helps to keep you warm. Honey gives you sugar.

Plan a luncheon made up only of vegetables. Start out with tomato juice. May you use butter on your bread? Jam, jelly, or peanut butter may be used instead. In place of milk you may drink orange juice or grape juice. You may have a tasty vegetable salad. The dessert may be fruit.

That would not be a bad lunch would it? The thing that would bother you most would be absence of milk. A vegetable luncheon every day might not be so good for growing boys and girls after all.

Now try planning a luncheon of only animal food.

What will you have? Chicken soup to begin. Then a lamb chop and cottage cheese. Oh, yes, milk to drink. No bread, no salad, no vegetable. And what for dessert? How would a custard do, made of milk and eggs? But it must not have sugar or vanilla in it, for both of these are made from plants.

MAN USES ANIMALS FOR CLOTHING

Long ago people learned to use the skins of animals for clothing. By cleaning them carefully and soaking them, they softened the skins. People living in cold places on the earth found the skins of many animals warm and comfortable. Plants were scarce in these cold places; so animal skins were used for clothing.

Have you ever seen an Eskimo suit? Eskimos use skins of polar bears and other animals to make their warm suits. Each suit has two skins. The under one has the fur on the inside. The top one has the fur on the outside. Two layers of fur keep the Eskimos warm enough in their cold northland.

How lovely the Indian suits are! They are almost always made from the skins of animals. Some of them have beadwork on them. Others are painted in bright colors. Some Indians use animal skins for their houses too.

You wear animal skins. What are your gloves made of? Yes, and your shoes? Have you a fur collar on your winter coat? All of you have sweaters. They are made from the warm wool which grows on the sheep's back. Your heavy winter clothes are probably made of wool, too.

Some animals have beautiful fur skins. The beaver, fox, mink, and seal do. These animals are trapped and killed. Their skins are used for fur coats, capes, and

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Eskimos wear clothes made from the skins of animals

National Museum of Canada

Beaver

Mink

Silver fox

Wolf

Seal

hats. Cloth coats are often trimmed with the fur of these animals.

Perhaps you have a sheepskin coat. If you live where the winters are cold, you will find such a coat very useful. The wool of the sheep is used to line the coat.

What other things do you wear that are made from animal skins? Do not forget about your leather shoes and belt. What about your gloves and sweater and purse? Are they made from the skins of animals?

MAN USES ANIMALS FOR SHELTER

There are some people who build their homes of animal skins. Such homes have these advantages: They can be built quickly. They can be taken down easily. They are light enough in weight to be carried to a new place.

For these reasons many tribes that travel about from place to place use skin shelters. These tribes often move to find a new supply of food for themselves or for their herds of animals.

Some Indian tribes used to live in skin tents called tepees. The skins were thrown over a frame of poles. A hole was left at the top of the tepee to let the smoke out.

Some Eskimo homes are made of skins. The skins of the walrus, polar bear, and seal make good shelters for Eskimos when the warmer weather arrives.

Many desert tribes live in skin tents. They move about in search of food for their herds. The tent shelters are easily moved. They are just rolled up and taken along.

People who live in cities or on farms do not use animal skins for homes. They build their homes of bricks, stone, or wood. Such homes last longer and are better for people who do not move around so much.

SOME ANIMALS EAT OTHER ANIMALS

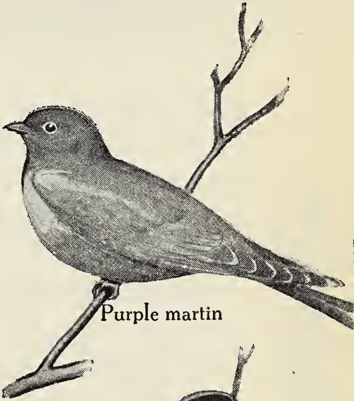
Scientists tell us that if all our birds were destroyed, it might be only a few years before man and all animals of the earth would begin to starve. The birds shown on the opposite page all help us. We should protect them.

Birds help us by killing insects. Without the birds, the earth would soon be full of buzzing, crawling, creeping, hopping, flying insects. These insects, feeding upon plants, would soon destroy them all. They would eat the leaves of the trees and bushes and the seeds of other plants. Without plants, animals which depend on plants for food would soon die. Without plants and those animals which man depends on for food, we too would soon die.

If you have ever been camping near a lake in the summertime, you know how many mosquitoes there are to bite you. They never let you alone. Imagine how many, many more there would be if thousands of them were not eaten up daily by birds.

Then there are the garden pests which the birds destroy. The cutworms, the grasshoppers, and the beetles,

Robin

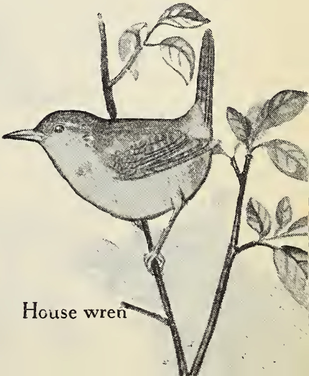


Purple martin

Rose-breasted grosbeak

Song sparrow

Meadow lark



House wren

which destroy plants, are all food for many of our birds. Even the crows, which many farmers shoot, do more good than harm. Crows eat corn, to be sure; but they also destroy thousands of harmful insects which are the farmers' pests.

Think of all the other birds that help us. Robins, grosbeaks, song sparrows, tree sparrows, meadow larks, wrens, and martins are all busy keeping down our insect pests.

Birds not only eat insects. Some of them eat seeds. Many of the seeds they eat are weed seeds which farmers do not want in their fields. Of course birds also eat some

Do you know how each of these animals helps the farmer?

of the grain which farmers want. But the good they do by eating weed seeds makes up for the little harm they do. If you are wise, you will protect the birds.

The garden toad is a helper of ours, too. It is an insect-eater. While we are asleep, the toad hops about eating many insects that fly at night.

We must not forget the snakes. They too are very helpful. They eat the mice that do so much harm to the farmers by eating their grain. Only a few kinds of snakes are poisonous. Those that are not poisonous should be protected.

The pretty ladybugs feed upon tiny plant lice and plant scales. They should be most welcome visitors in your garden.

While too many insects are a pest, it is really a good thing that there are insects in the world. They furnish the main meal for thousands of our smaller animals. It is true that too many mosquitoes cause suffering to man and beast. But mosquitoes are also food for many animals which are helpful to man.

Of all the thousands of different kinds of insects scattered about the world, only a small number are pests. Man's problem is to help other animals to control these pests so that they do not bother us too much or cause us harm.

ANIMALS ARE USEFUL IN OTHER WAYS

Man uses animals in many other ways. He uses horses, mules, oxen, elephants, and dogs to carry his heavy loads.

Another way that animals help us is by helping plants. As bees and other insects fly from flower to flower after nectar, they get covered with pollen dust. They carry the pollen dust from plant to plant. This helps the plants to make more plants. Red clover depends upon the bumblebee to carry its pollen. Whenever you see red clover, watch for the bumblebee. It is sure to be about.

Perhaps you think earthworms are only good for fish bait. This is not true. Earthworms are very useful to the farmer. They help to plow the farmer's soil. They bring bits of plant food up near the surface of the ground. They crawl about in the earth, loosening it. Plants grow better because of all the things which the earthworms do.

Bumblebees carry the pollen of red clover to other clover plants

Lynwood Chace

Earthworms are useful in another way. They eat dirt. By so doing they make the plant and animal material found in the soil decay more quickly.

THINGS TO THINK ABOUT

1. You have been reading about the ways in which man uses other animals. Perhaps one of the most important things that animals do to help man is to eat other animals. In this way very few animals become man's pests. Each animal has other animals which eat it. Birds eat many insects. Mountain lions eat deer. Coyotes eat jack rabbits.

2. Look about you to see what the animals in your neighborhood eat.

3. Do not be too quick to think that an animal is harmful. You may see a little bird eating the ripe fruit on your best cherry tree. You may see a crow feasting upon the corn you planted in your garden. Before you think of harming the animal, think of how much good the animal may be doing you.

4. All living things are related If you kill the crows and other birds because they eat your fruit and grain, you will have a great many more insects in your neighborhood to destroy the plants in your garden or field.

5. Try to learn all you can about the animals that live near you. Learn how they affect one another. Then you will be a help in keeping the living things in your neighborhood right.

THINGS TO DO

There are some animals which have become very scarce. Some have even become extinct; that is, there are no more of them alive. Find out which animals are protected by law. See if you can help to protect these animals by learning the truth about them and telling other people what you have learned about these animals. Be proud of helping to protect the animal life of your neighborhood.

VIII

Some of Our Resources and How to Conserve Them

AMERICA AS THE WHITE MAN FOUND IT

SOIL AND THE PLOW

FORESTS AND THE AX

WILD LIFE AND THE KILLER

RIVERS AND THEIR FLOODS

CONSERVATION A BIG PROBLEM
FOR ALL OF US

ONLY four centuries have passed since the first white men came to the shores of North America. They found here a great land with many rich natural resources. There were millions of acres of beautiful timber for them to use. Some of the soil was more fertile than any they had ever seen. Wild life was found in great numbers. Deer, buffaloes, fish, and birds by the thousands lived upon the land. America was indeed a rich place to come to.

Men set to work with ax and plow. They started using the rich resources they found here. Many of these resources were used wisely by the people who came to live here. Some of the resources have been wasted. This chapter tells the story of the use and waste of the natural resources of this country during the last four centuries.

America As the White Man Found It

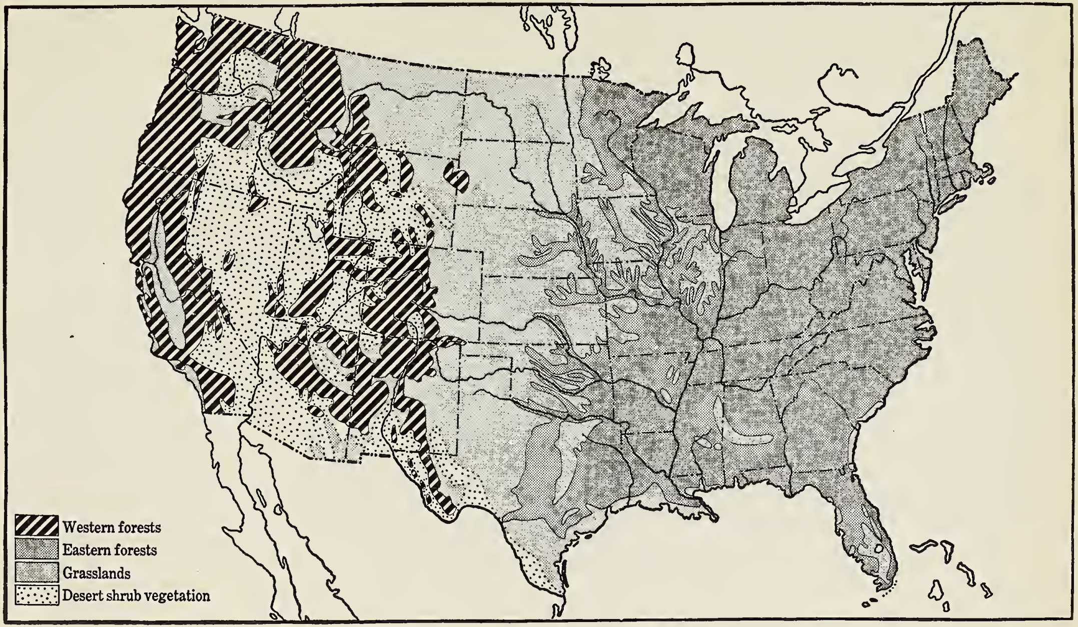
Only four centuries have passed since the first white men came to live in North America. Only four hundred years and yet what changes have been made!

To those who first came to its great forests and spreading plains and winding rivers it must have seemed very large indeed. So it was then, and so it is today. America in 1492 was a huge storehouse for the people who came here from Europe to use. It was a land so full of riches that man could not imagine ever using them all.

These many riches which the early settlers found here we call resources. We often speak of them as natural resources, because they were not made by man.

Much of America was covered with rich fertile soil. Millions of acres of it spread out between the two oceans. For century after century this rich soil had been forming. Plants had grown upon it, taking rich materials from it. When they died they gave back to the soil more food than they had taken from it. They helped to build more and richer soil. When winds came, the plants held this rich soil to the earth. When heavy rains fell, the plants kept the same rich soil from washing away.

Some of the land was covered with great forests of pine and fir, of maple and oak, of cedar and walnut. In all there were many millions of acres—820 millions of acres of timber growing in North America.



This map shows how much of the United States was covered by forests and grasslands four centuries ago

Some of the land was covered with thick green grass. The wide prairies of the West were such grasslands. For miles these grasses spread out over the soil, keeping wind from blowing it about and rain from washing it away.

Animals were everywhere. And why not? There was plenty of food for them. The buffaloes found more grass than they needed on the grasslands. Deer, elk, and moose ate as much as they needed, as they traveled from one place to the next. Birds and smaller wild life enjoyed the food and shelter of the forest and grasslands, and were found there in great numbers.

The streams had many fish in them. In fresh-water streams and lakes were found bass and pickerel, trout and salmon. In salt-water bays and along ocean shores were oysters, clams, and other shellfish, as well as cod, mackerel, and swordfish in great numbers.

Scattered about here and there over this wide country lived the Indians. There were less than a million of them in all. How long they had lived in this country we do not know. That they had lived here for a good many years we are sure.

The Indians had simple ways of living. Some of them had cleared away the trees from small pieces of land and planted corn or squash or beans. That was about all the farming the Indians did.

With bows and arrows they hunted buffaloes, deer, wild turkeys, and ducks to use as food. Good as their bows and arrows were, there was no danger of their destroying too much wild life. They were good fisher-

United States Forest Service

Beautiful trees like these were found in great numbers in America

© Photographic History Service[1]

The pioneers found great herds of buffaloes grazing on the western plains

men, and took part of their daily food from the clear cool streams. Their houses were simple things made from the trees they cut down or from the skins of animals which they killed.

Here was to be found good soil, fine forests, and wild life. The Indians used some of the great resources which were everywhere about them. They got their living from them. But not much of any of the rich natural resources of the country were used. The Indians changed the country very little.

Then came the white man.

[1] From the motion picture *The Big Trail*, by Fox.

THINGS TO THINK ABOUT

1. North America is one of the richest lands in the world today. It has many fine resources of forests and rich soil and wild life. There used to be more of them than there now are. We have used our resources to feed and house our people. That is right. But we have wasted some of our resources, too. We must stop wasting. We must learn how to use what we have and still save some of it for others who will need it later on.

2. Other countries are rich in natural resources. Some of these countries have learned how to use their resources and still save some for years to come. The farmers of some parts of Europe have had to grow crops year after year on their small pieces of land. They had to take good care of the soil. If they didn't, they knew they would starve. In America, where there was more land, we have kept wearing out one farm and then moving on to another piece of land. Now that there is no more land to move to, we shall have to take better care of our farm land.

THINGS TO DO

1. Look for pictures that show how North America looked in 1492. Put them on your bulletin board. Now find pictures of North America today. Put these on your bulletin board, too. In what ways has the country changed?

2. Invite some older person, perhaps some child's grandfather, to come and tell your class about North America when he was a boy. Perhaps you can find someone who has worked in a lumber camp. He could tell many interesting stories of life in a lumber camp.

3. Make pictures for a movie which show some of the changes that have taken place in North America in four centuries. Show your movie to other classes.

SOIL AND THE PLOW

The pioneers who came to North America used the ax first. They cut the trees and cleared the land. Then they used the plow. In the East and Southeast the hilly timber lands were plowed and crops were planted. Much of this land was not fit for raising farm crops. Much of it was so hilly that as soon as its ground cover was plowed under, the topsoil was free to wash away with every heavy rain.

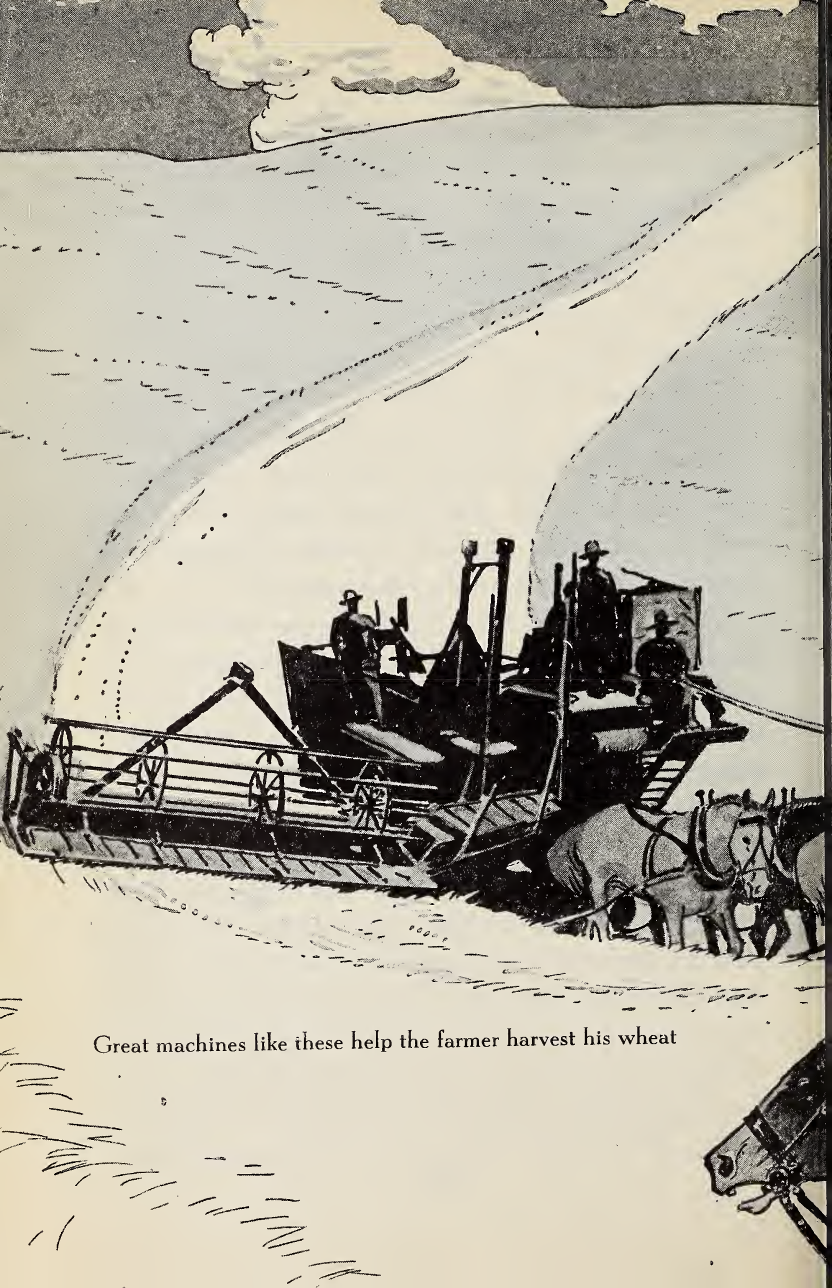
There was a thick layer of topsoil on some of these hillsides. For many years the farmers who worked this land made a good living. But finally so much of the topsoil was lost by erosion that the crops grew poorer and poorer. Many farmers could not raise enough food for their families. Today in New England hundreds of farmers have given up trying to make a living from their hilly farm lands. Some have moved to cities to find work. Others have gone to better farm lands to make their homes there.

The pioneers went west. First they went by tens, then by hundreds, and later by thousands. In some places they found great timber lands to be cut and plowed. This was true of the regions of Michigan and Wisconsin. In other places they found a great many level grassy plains. Many of these grassy plains were used as grazing lands for cattle or sheep. These grasslands became the center of the meat supply of North America.

Great herds of cattle found a fine living on the grassy plains and hillsides. For a while there was plenty of food. But the meat business was a money-making one. The herds grew larger. More and more cattle grazed the land. When the cattle could no longer get food from the land, sheep were brought in. The sheep ate the grass right down to the roots. The hoofs of the millions of animals cut deeply into the soil and made it loose. It was then easier for the wind to blow it away. Often there was a dry summer and grass plants did not grow. Herds had to be sold quickly or they would starve. Slowly, year after year, these once rich grazing lands have become poor grazing lands. Millions of acres of grazing land have been destroyed by too much grazing.

Parts of the Great Plains have become the corn and wheat belts of America. These lands were among the most fertile farm lands of the country. Year after year they have kept on giving the farmer good crops. In dry seasons there was not so much money made. In wet seasons the farmers would have a large harvest and make up the losses in the dry seasons.

But even these fertile lands must have good care or they do not keep on raising good crops. Sometimes farmers keep right on planting the same crop in the same fields year after year. In the corn belt the farmers may plant corn in the same fields for several years. In the wheat belt they may plant the same fields to wheat for too long a time. We call these farms one-crop farms, because the one crop is planted in the same place year



Great machines like these help the farmer harvest his wheat

after year. The materials which the plant needs must come from the soil. After a while these materials run out. Then a good wheat or corn crop can no longer be grown on this land.

In the southern part of the United States some cotton and tobacco farmers have made the same mistake. They have raised one crop on their lands for several years. Now their land is worn out. These farmers must change their ways of farming. They must build the land back by using fertilizer and by planting other crops in place of the one they used to plant.

Beginning in 1914 this country was greatly affected

This farm has had most of its topsoil blown away

Farm Security Administration

Farm Security Administration

The government has helped many farmers improve their farms

by the World War. The armies had to be fed. There was no time to waste. Bread was needed. Wheat had to be grown for it. The shiny new tractors set to work. Hundreds of acres of grasslands were plowed under. Even some forest lands were cleared and plowed and planted to wheat.

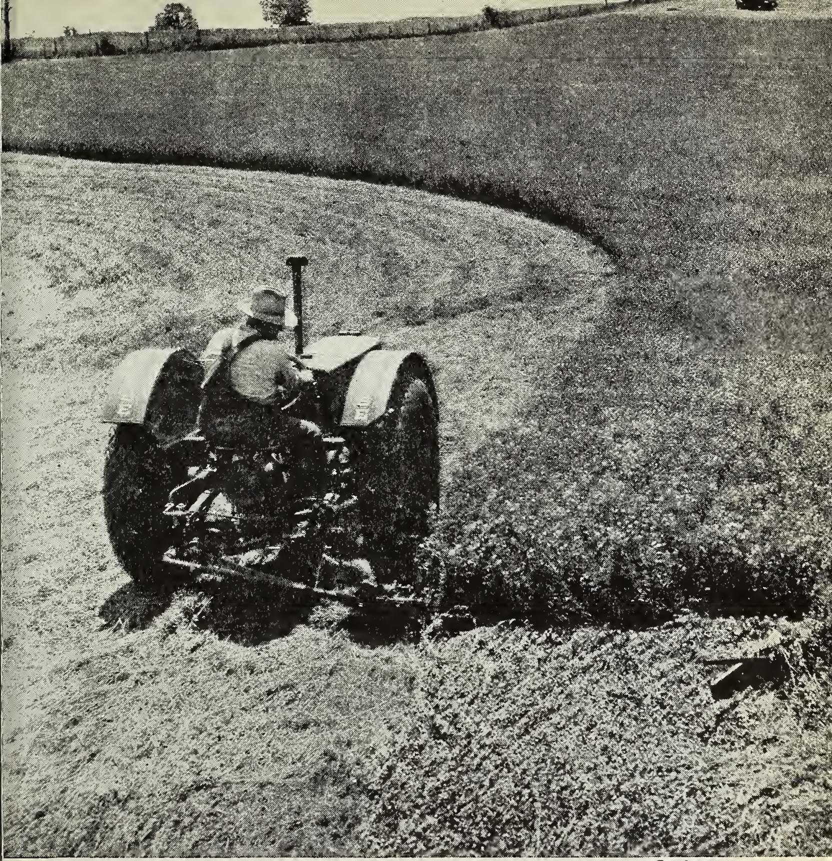
Much of the land that was planted should never have been plowed. In the dry seasons that followed one upon another, wheat could not grow upon it. During these years the land became bare. It began to blow away. The great dust storms followed. Farmers who had once had much money from their harvest of wheat grew poor. They saw the best part of their farms being blown away. Many of them were forced to leave their farms and find a living in other places. Hundreds of them suffered for want of food and shelter. The government had to help them during these hard years.

There was a time when topsoil was being made faster than it was being washed and blown away. That was the way it was when the white men first came to North America. The ax and the plow upset the work of nature. The ax cut the trees. The plow destroyed the cover of plants on the ground. Millions of acres of fertile land were left free to blow about and wash away. Before long the topsoil was being lost faster than it was being made. So after only four centuries parts of America face the danger of becoming one of the largest deserts of the world.

SAVING OUR SOIL

One of the first presidents of the United States to start working on the problem of saving soil was Theodore Roosevelt. He said, "When the soil is gone, men must go." While he was President he had the government buy back large forest lands. In this way he helped save the soil from erosion. Forests help keep the soil from blowing about and washing away.

Since 1920 many people have been working away at this problem of saving the soil. They call it conserving the soil. We are hearing a great deal about what the



Gendreau

Alfalfa makes a fine cover for topsoil

people are doing about conservation. We know some of the things that have been done to conserve our forests. Let us now see what is being done to help save the soil.

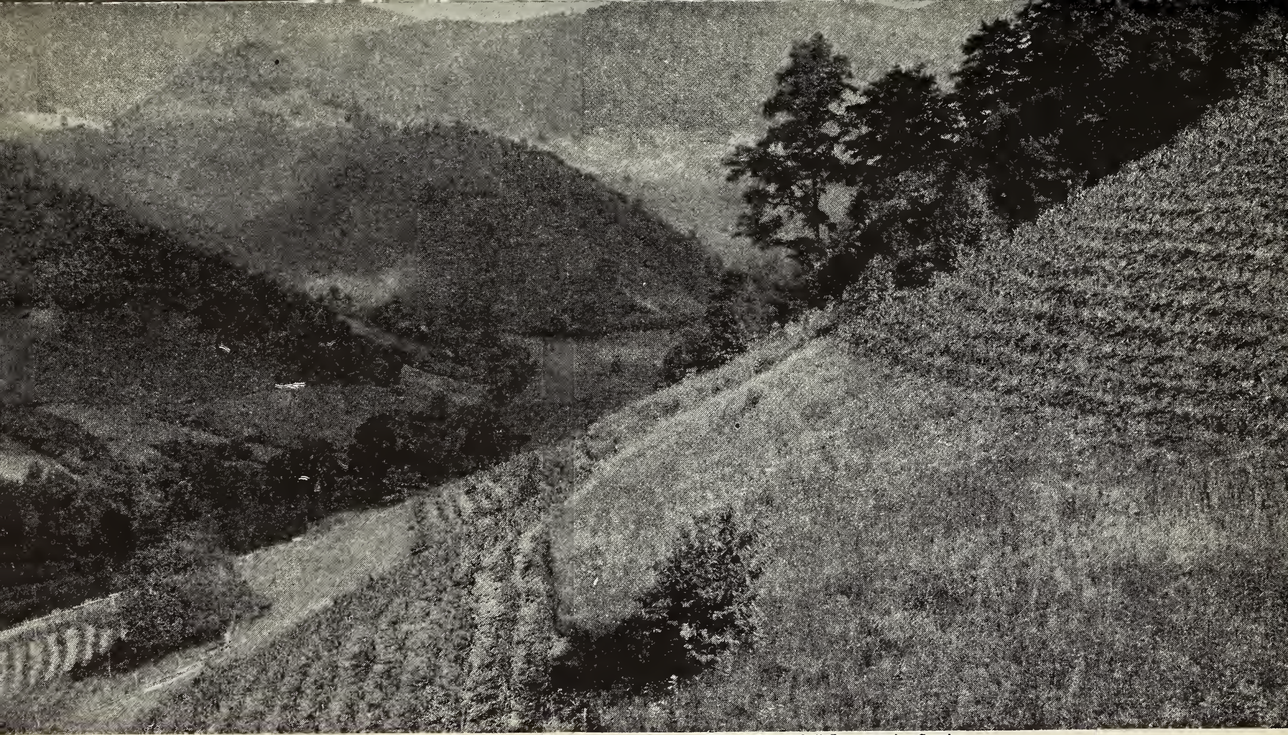
It is believed that North America loses about 400 million dollars' worth of topsoil each year. This money cannot be made up, for when the soil blows away or washes into the sea it cannot be brought back. It is gone forever.

What must be done then is to find some way of keeping it in place. The ground must be covered with plants, so that the soil will be safe from erosion. Here are some of the ways people are trying to save the soil:

Much of the land which was plowed and farmed is now being planted with grass again. This is more true of steep, rolling land than of flat land. Such rolling land, if planted to corn or potatoes or other crops which grow in rows, is washed away much faster than if planted to hay or other grasses. These grasslands are being used as pasture lands and give good results. There is much less loss of soil on such grassy hillsides.

But all of our land cannot go back to pasture and forests. There are about 136 millions of people to be fed in the United States alone. They must have wheat and corn and other crops. Often farmers who own hilly farms have to plow the hillsides in order to raise crops enough for even themselves. In such cases there are ways of farming which the farmers and the government, working together, have learned.

Much of the land used to be plowed up and down the hillsides. Many fences ran that way. The farmer plowed that way. This is what happened: With each heavy rain the topsoil was carried down the paths made by the plow furrows. You see this way of plowing made it easy for the rain to rob the farmer of his fertile soil.



United States Soil Conservation Service

Steep slopes can be farmed so that the soil does not wash away

Now the farmers plow their hillsides in the opposite way. Instead of going up and down the hillsides they go back and forth across them. In this way each plow furrow acts as a dam to hold the water back and to make it harder for the rain to rob the farmer of his topsoil.

Some farmers are saving the soil on their hillsides by plowing it in a way that makes the whole hillside look like big stairsteps. The crops grow on the level part of each step. Can you see how these stairsteps would help hold the water back when rains come?

In Europe many farmers make these stairsteps on their farms. They do so because even the steepest hills have to be farmed in order to raise food enough for all the people. Here in North America we have more land to farm. We do not need to farm the very steep hills. For that reason this kind of stairstep farming is not used as much here as it is in Europe.

Many farmers are planting their hillsides in strips, or bands, of two or more kinds of plants. Instead of planting a whole field to corn they plant one strip to grass. They then plant another strip to corn, and another to grass, and so on. The strips of grass save the soil and water. The corn land cannot be washed so badly. It can only be carried to the next lower grassy strip.

If this hillside is farmed the next year, the crops are changed about. Corn or potatoes are planted where the strips of grass were planted before. And the grass is planted where the corn grew the year before.

United States Soil Conservation Service

Many farmers plant crops in strips like these

Changing crops from one part of the farm to another is called crop rotation. Most farmers now use this way of farming. In so doing, the same kind of material in the soil is not used year after year. Some plants give back nitrogen to the soil. Here it is stored for other plants to use. Clover and soybeans are very good plants to use. Many farmers plant them every two or three years to make the soil better. Other crops are planted after the clover or soybeans have been harvested.

Farm Security Administration

Gullies grow fast in places where the topsoil is left free to wash away

Have you ever watched what happens on a steep plowed hillside in a heavy rain? Have you seen the small paths, or ditches, which form and carry the water away? With each new storm these small paths become deeper and wider. Before long they are so large that we call them gullies.

Gullies grow very fast on rolling farmed land. Some of them get to be hundreds of feet deep. Whole counties have been made useless as farm land because these gullies have grown so large. Some of the gullies in the southern part of the United States have cut back so far that farm buildings are in danger of being destroyed.

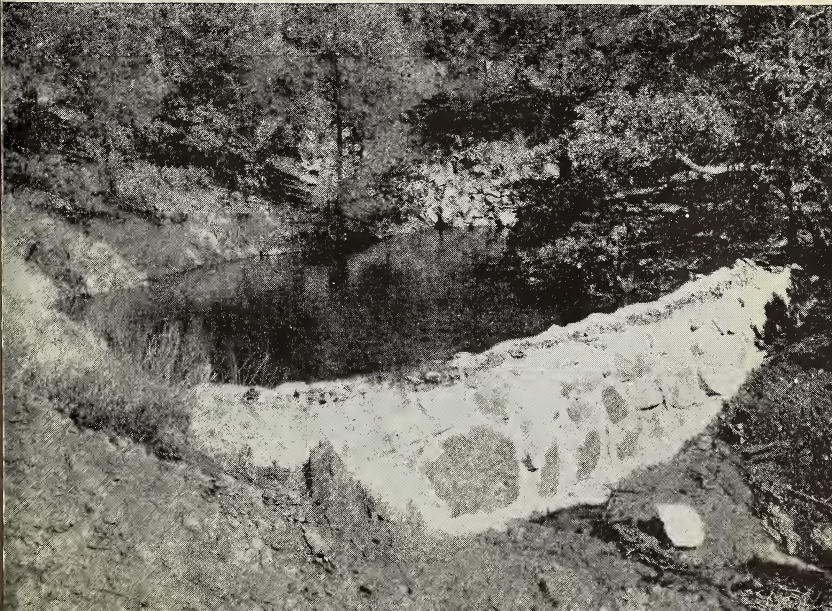
Land that has deep gullies in it is hard to farm. It is not easy for the farmer to plow back and forth across the hillside because of the steep side of the gullies. Each new rain makes the gully grow deeper and wider and takes away more topsoil from the land.

In parts of the country where gullies have become bad several things are being done. Some grasses can grow even on the steep sides of the gullies. These grasses have been planted in many parts of the country to keep the gullies from growing larger.

Sometimes the gullies are so large that small dams of stones or logs are built every little way down the gullies. These dams slow up the flow of the water. It is

This check dam helps to save the water supply for later use

United States Soil Conservation Service



easier for the grass to get a good start when the water from each rain cannot flow down the gullies so fast. Such dams are built only to help the grass get a start. They cost money. It is much better to plant the grass while the gully is still small and to stop it from cutting wider and deeper into the farm land.

The pasture lands of the West can be saved by not letting too many animals graze on the land. Then the roots of the grass will not be loosened. The soil will not be cut up by the feet of the animals. The pasture lands will keep on growing grass for years to come.

In 1934 a great dust storm carried tons of rich topsoil from the great wheat plains of the country. These fields were once called the "Bread Basket of North America." They are now called the "Dust Bowl." You have already read how some of these once rich fields have become desert lands.

Much has been done in this region to stop the dust storms. The farmers have worked together. They have plowed the land in the right way. Many acres of land have been planted to grass and trees. This land is no longer being left free to blow away. It will take a good many years to do all the work that needs to be done to save the land in the Dust Bowl. Good work is going on there each year. Better crops are already being grown.

There is still much to be done not only in the Dust Bowl but in other parts of North America. Forests must be planted. Grasses must be grown. Better ways of farming must be found. Our soil must be saved.

These fields were once the bread basket of America

THINGS TO THINK ABOUT

The World War made great changes in Western farmlands. It speeded up farming. There was great need for wheat to feed the soldiers. Farm land rose in price. Many acres of land were plowed and planted to wheat. Much of this land would not raise good wheat except in rainy seasons. Several dry seasons followed. The wheat crop was small. Farmers who had bought their farms at high prices found that they could not pay for them. Many farmers found themselves getting poorer and poorer. Some of them lost all the money they had put into their farms. Many farmers were forced to leave their farms because of the dust storms.

What is now being done to save the land of the Dust Bowl?

THINGS TO DO

1. Go on a walk around your school just after a rainstorm. Look at the soil. See what changes the rain has made in the land. Can you find gullies being formed? Can you find places where soil has been carried along by the streams and left on other parts of the land? Do gullies seem to happen on the grassy places or on the cultivated places?

2. Find a piece of land to study. It may be a cut made for a new road. The banks of the cut are usually steep. It may be a bank of a stream. Watch what happens to this land during the year. Look at it after each storm. Watch it in the spring of the year during the wet season.

3. Go to a near-by forest land. Look at the carpet of leaves and twigs under the trees. Feel of the layer of ground cover. Is it dry or moist? Can you see how such a layer protects us from floods?

4. Invite someone to talk to your class about ways people are working together to save the soil.

FORESTS AND THE AX

The first white men to set foot upon the eastern shores of North America found great forests everywhere. Most of these early settlers had come to America to make homes for themselves and to earn a good living. Many of them were farmers.

They set to work cutting down the trees and clearing pieces of land for farming. Their log houses were built from the trees they cut. Their food was cooked over the roaring open log fires which they built in the big fireplaces in their log houses. They used the tall straight white pine logs for masts for the ships which were to cross and recross the Atlantic.

These ships and others kept bringing more men and women from Europe to America. The new settlers needed to make homes for themselves and to earn a living for their families. Axes went to work again. This time more trees were cut in order to furnish timber for houses, and also that the land might be cleared for farming.

As time went on many ships traveled west to America. Travel was less dangerous. Stories spread of a rich new land across the Atlantic. Over there one could find money and happiness. So on they came.

The eastern shores became more crowded than some of the settlers liked. To the west spread miles and miles of good land covered with forests. "Let's go where there's more room and more riches," they said.

The pioneers cut the trees to make homes for themselves.

They cleared the land for farming

Some made flatboats and floated their goods and families down the broad streams leading westward. Others built boatlike wagons and moved their goods west through mountain passes or along river valleys.

Ahead of them stretched acre after acre of forests. There was more than they needed for their homes, more than they could imagine man would ever be able to use. There was so much timber everywhere that they became careless about how they used it. When they needed land for farming they cut the timber and made huge log bonfires in order to get it out of their way.

The white men who first came to America to make homes and to farm did not do a great deal of damage. There were so few men and so many forests. At that time about one half of the land of America was covered with timber. There were more than 800 millions of acres of it. Surely the early settlers had a right to cut away some of the timber in order to farm the land.

Today there are only about 200 millions of acres of forest fit for lumbering. What then has happened to these hundreds of millions of acres of timber? Men found out there was money to be made in lumbering. Big lumber companies were formed. These companies got the government to sell them great timber lands at cheap prices. Lumbering really started in America then.

The white pine was the first to be cut. It was so straight and tall and could be sold for a good price to the many shipbuilders. Axes chopped away at the pine in New England. When the best of it was cut, the lumber companies bought forest lands in the pine belt of Michigan. Again the axes chopped until the best of the pine was cut down. On went the lumber companies to the Pacific Northwest, where with saw and ax they again went to work.

These lumber companies were interested in cutting trees to make money. They did not wish to farm the land. They did not care about what happened to the smaller trees they left behind. Only the larger trees were wanted. In order to get the big trees out, the smaller trees were often cut down, too. These were left to rot where they had fallen or to catch fire and burn.

Lumbering was once one of the great industries of America. It could have been carried on in such a way as to save rather than waste the forests. Careless and wasteful lumbering has done much to destroy one of America's greatest natural resources.

FORESTS AND THE SOIL

Today we are the losers. Many of our forests are gone. As we shall see, these forests are important to us in many ways. Let us first see how cutting away our forests affected the soil.

Plants grow in the layer of topsoil which covers the earth. It takes about five hundred years to make an inch of it. Four centuries ago the topsoil of some of America's best farming land was about thirty inches deep. Today our best farm land has a topsoil cover of less than ten inches. In many places all of the topsoil has been carried away, leaving only desert land behind.

As you know, there are two great forces which carry topsoil away. One is wind. The other is water. Wind blows topsoil away, and water washes it away. We call this work of wind and water erosion.

The trees of the forest slow up the work of erosion. Their many roots reach out in all directions and help hold the soil to the earth. The roots of the trees bind the soil so that it cannot easily get away.

When there is a heavy rain the trees help, too. Each raindrop hits against the leaves, branches, and trunks of the trees. In so doing the raindrop is slowed up so that it strikes the ground with less force. Another way of thinking about it is that the trees form a sort of cover,

Rain cannot wash away topsoil in forests where the ground cover is thick

United States Forest Service

or umbrella, over the ground and break the force of heavy rains.

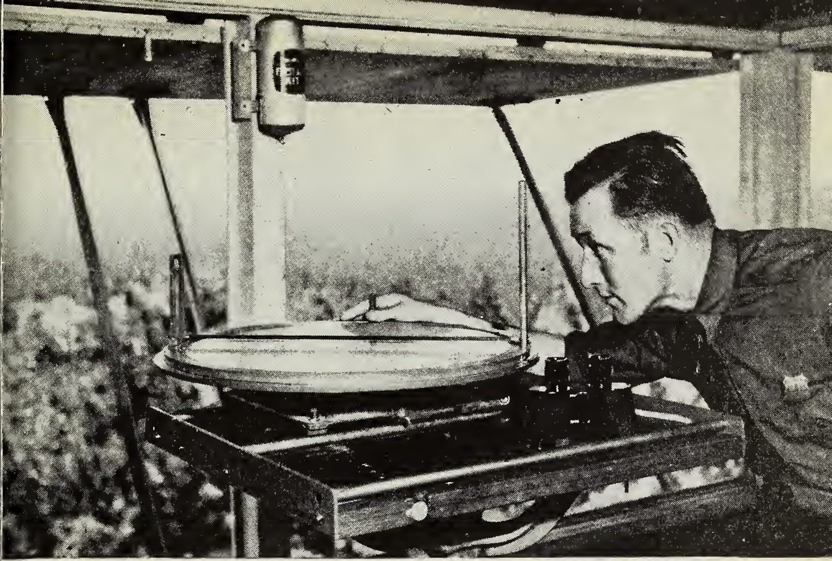
When the drops do finally hit the ground there is a thick carpet of living plants, dead leaves, logs, and twigs. The water must trickle through this carpet into the ground below. Each leaf and twig acts as a tiny dam to slow up the flow of the water. Now that is just what we want. The water sinks into the ground. It does not rush off down the slope to the streams below. It gives food to the roots of the trees and plants instead of carrying topsoil away.

We say that forests stop fast run-off of water. They help water to sink slowly into the ground rather than to run off the top of the ground. Of course no one needs to tell you that when water runs off quickly it carries topsoil with it. Once topsoil is carried away it takes perhaps hundreds of years to replace it.

Forests help prevent erosion by wind, too. The roots bind the soil to them. The leaves and branches break the force of the wind. Great dust storms such as you see on bare farm land never occur on the forest lands of the country.

SAVING OUR FORESTS

How then can we save our forests? That is a question which all of us should help answer. First let us see whether anything is being done about it. Only since the close of the last century have the people of North



United States Forest Service

Forest lookout men keep watch for forest fires

America begun working to save the forests. They have come to know how valuable forests are in slowing up erosion by wind and water. They have also seen how fast the great timber of this country was being cut down or destroyed by fire.

One of the ways the governments of the United States and Canada are helping to save forests is by buying large pieces of forest land, so that it cannot be wasted by bad lumbering. The Forest Service has charge of the care of these government forests. They have lookout men who watch over the forests. You have probably seen these lookout men in their tall fire towers. They watch for signs of forest fires. The lookout men report fires by radio or telephone to the

United States Forest Service

Forest fires destroy the ground cover and then topsoil washes away easily

forest rangers, who rush their fire trucks and men to fight the fire.

Sometimes the fire-fighters try to stop the fire by digging wide ditches to keep the ground fire from spreading. Sometimes they start a backfire, which burns toward the real fire. When the two fires meet, they both go out. It is often necessary to cut a wide path of trees, so that the fire cannot spread.

Even though the forest rangers do fine work in fighting fires, more than 50 million dollars' worth of timber is burned each year. Almost all of these forest fires are caused by careless people. Campers forget to put out their campfires after a picnic supper. Smokers throw their lighted matches along the roadside. Small fires started by persons who are clearing land sometimes burn too fast and spread to forest lands.

Surely all of us should do everything we can to help save forests from fire. When forest lands are burned over, the ground cover is gone. The topsoil is left free to blow about and wash away. The picture shows you just how this burned over forest land looks. No wonder it blows about.

The Forest Service has other jobs besides fire-fighting. It takes charge of planting trees on cut timber land and on burned forest land. We call this replanting of trees reforestation. It means planting trees where there were trees before. Tiny trees called seedlings are grown in government nurseries. These seedlings are planted on the timber lands. Many thousands of such three-year-old seedlings are being taken from the nurseries and planted on burnt-over and cut-over timber lands each year. After they are planted, they are carefully cared for until they have grown larger. It takes money to grow and plant trees. If the young trees were not looked after, much money would be wasted, because many of the seedlings would die.

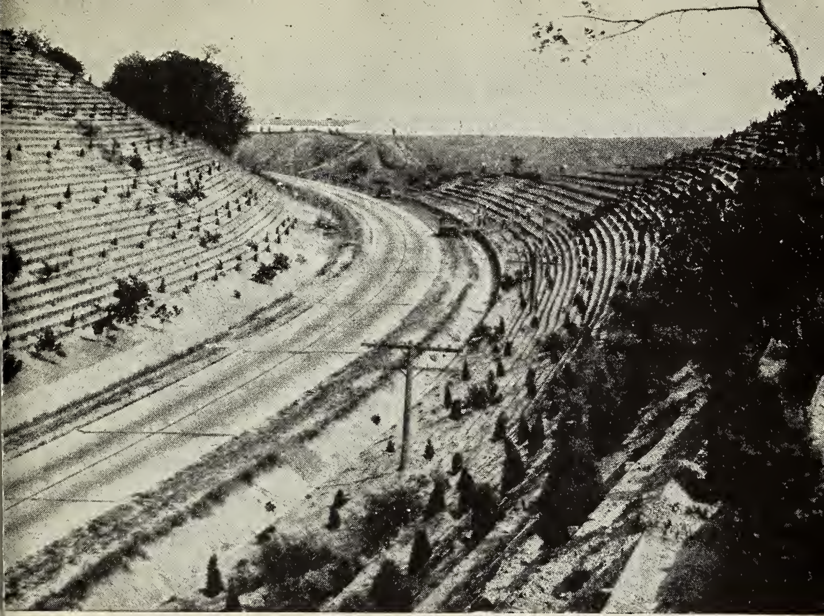
The Forest Service takes charge of cutting the trees which are ready to be cut. Each year men go through the government forests and mark the trees that are to be cut. They leave the young trees, so that they may grow into large trees. They take no more trees out of the forest than they replant each year. In this way lumbering can be done and still the forests are not destroyed.

You may get your Christmas tree at the corner store. Every year many young trees are planted to replace the trees used in homes at Christmastime. As long as more trees are planted than are used, we need not be afraid that our supply of Christmas trees will destroy forests.

Harmful insects often destroy trees. The Forest Service helps to fight the spread of harmful insects and tries to destroy them. In Montana there is a tiny

Young trees are being planted on this worn-out pasture land

United States Soil Conservation Service



United States Soil Conservation Service

The steep sides of this roadside are planted to trees to keep the soil from washing away

beetle which has destroyed whole forests of pine. The Forest Service is fighting the spread of these and other harmful insects which kill trees.

Another job of the Forest Service is to stop too much grazing of wooded hillsides. Much damage has already been done by turning too many animals out to graze on one piece of land. The foresters rent the forest lands and allow only the right number of sheep or cattle to graze on a given piece of land. In this way the ground cover is not destroyed and the topsoil does not wash away.

We are glad that the governments of Canada and the United States are at work to save the forests of North America. But we must not leave all of the work for them to do. Each of us should help in our own schoolyards, our farms, in camp, along the highways, wherever we live, to care for the trees which grow there. We can plant seedlings and keep them safe while they are growing. We can train ourselves and others to be careful about fire, so that forest fires never start because of carelessness.

All of these things and more too must be done NOW and for years to come, in order that one of our great natural resources may be saved for those who are to live in America many years from now.

THINGS TO THINK ABOUT

Lumbering was once one of the leading industries of our country. Great lumber mills sawed away at the big logs. The rivers were filled with logs being floated from the woods to the mills. Hundreds of towns grew up because of the lumber business. Thousands of men found work in the camps and mills.

Today there is no such lumbering industry. Most of the great forests have been cut over. Many of them have not been replanted. Thousands of acres of land once rich in forests are now being wasted. Much of it is not fit for farm land.

How have the wasteful ways of lumbering harmed the country?

What is being done about replanting forests so that we may again have fine forests?

THINGS TO DO

1. Plant seedlings at home and in your schoolyard. Care for them so that they will be able to grow into fine trees.

2. Find out all you can about the ways to prevent forest fires. Give an assembly and try to help others to be more careful to save our forests from fire. Some of you might give speeches telling about:

Why we should protect our forests.
How forest fires may start.
What happens to the birds and other animals that live in the forest when a forest fire starts.
How forests help save the soil.

Eagle
Mountain lion
Elk
Grizzly bear
Heath hen
Buffalo

Wild Life and the Killer

The men who came to North America found wild life everywhere. The forests were full of deer, rabbits, and foxes. The marshes were the homes of wild ducks and geese. The grasslands were the homes of thousands of buffaloes.

Some of these animals in woods and streams and fields were good to eat. The white men hunted in the forests and fished in the streams and took their fish and game home to be cooked and enjoyed. And this was right to do. After all, the woods and streams were full of wild life. It was right for men to use part of it.

There would still be much wild life left, had not the killer played so large a part in destroying it. The killer did not hunt for food for his family. He killed for fun. He often did not even take the skins of the animals he killed.

Buffaloes were shot by the thousands. Wild ducks were hunted and shot just for the fun of killing. Deer were killed by the hundreds. The killer boasted about his skill at killing. One man boasted he had killed 139,000 birds and other animals in a year's time. All of the animals which you see in the picture on page 280 used to be found in great numbers in America.

All of us know what has happened. Buffaloes became scarce. Deer and other animals had to be protected by law. Trappers could only set a given number of traps a year. Fishermen could take just a certain number of fish and no more. Our wild life was on the way to becoming extinct. The killer had to stop destroying wild life.

But the hunter was not the only killer of wild life. Many other men and women and boys and girls have harmed wild life. Some of these people have been killers without even knowing it.

The forests were the homes of many of our animals. As more and more of these forests were cut down, the wild animals had to search for other places to live. They now had to hunt for food, which had been easy to get in the forest. Their homes were destroyed. Their babies died.

Careless people destroyed the forests in another way, too. They burned them up. Every time there is a forest fire the wild life that lives in those forests is harmed. Many of the animals die, because they cannot get food to eat. Their nests and homes and young are burned. These careless people are killers, because they have burned the forests.

Not only are the animals of the forest harmed. The plants growing there are harmed, too. Some of our loveliest wild flowers grow on the floor of the forest. These plants are part of the carpet which is so helpful in keeping the soil from washing away. Fires often destroy the roots as well as the tops of wild flowers, so that they cannot grow again the next year.

Another way in which wild life has been killed is by clearing and plowing so much of the land for farming. Many of the smaller animals that once found homes and food on the grasslands were without these after the plow did its work. Even the fence corners were kept cleared, and the nesting places of the birds were destroyed.

Wild flowers were harmed wherever the plow went. Roots, seeds, and flowers were turned under. Many of the flowers that were once so plentiful are now very rare. Some of them are gone forever.

There were many marsh and swamp lands. For many years they were the homes of hundreds of water birds and other small animals. As more land was needed for farming, these swamps were drained. Some of them made fine farm land. But many of them were never used after they were drained, because they did not make good farm land. In the wheat belt of North America hundreds of acres of marshland were drained.

This land was the breeding place of many birds. It was too late then. The damage had been done. The homes of animals had been destroyed. The plants which grew there had been plowed under. And man had been once more the killer.

Cities have grown up through our land. These cities now stand on land which was once the hunting ground of many animals. Cities are not the best places for wild animals and plants to live. There are too many people and buildings and not enough food and nesting places. So the wild life that used to live where the cities now stand has gone to other places to live.

Many of our cities have been built on riverbanks, or lake and ocean shores. As the cities grew, they often killed the wild life of the water. Sewers poured the waste from factories and houses into the once clear streams. The fish were not able to live in this dirty water. So they died.

Have you been a wild-life killer? Perhaps you have without knowing it. Many boys and girls and men and women who love wild flowers have been killers. They have gone for walks in the country. Perhaps the trillium and the violet were in bloom. Perhaps the beautiful

The trillium needs your protection

Rutherford Platt

white dogwood was showing, or the fragrant arbutus was peeking through the carpet of leaves upon which you walked. And perhaps you set to work to gather a bouquet.

Many of us have done just that. Soon we had picked a large bouquet. We were delighted. How pretty they would look on the dinner table tonight. Before you reached home many of your flowers were drooping. The trilliums were a sight. They were hardly worth carrying the rest of the way. So you tossed them into the bushes. Hundreds of wild-flower bouquets meet that end every year.

One of the reasons that so many wild flowers are destroyed is the way in which they are picked. Most people do not stop to see that they pick only the flowers. They often pick flower, roots, and leaves. Many wild-flower roots are near the surface of the ground. They pull up easily. Then the plant is destroyed. If only the flower is picked, the plant can still grow. Many plants come up the next year from the roots, if they are not harmed.

There was a time when wild flowers were very common. There were enough so that picking large bouquets was not harmful. But that time is gone. There are now fewer places left for them to grow. We can no longer pick bouquets and not be counted among the people who are destroying wild flowers.

Again we ask ourselves "Is it too late?" Can we save our wild life? Is anything being done? Let us hope so; for a world without birds and deer and rabbits and wild flowers does not seem right. You wouldn't like such a world. Neither should I.

John Audubon was one of the first men in America to talk about conserving birds. He had studied them. He had come to love them. He also knew how helpful they were to man.

John Audubon tried to teach others to save the birds. He was against the killer who killed just for fun. Shooting for food was another thing. But shooting just to kill and not to use for food was not right.

He worked with others to get laws passed to protect wild life. Open hunting seasons were set apart. Some animals could be hunted only part of the year. Others could not be hunted at all. Each hunter could take only a given number of animals a year. Those who wish to fish and hunt have to get licenses in order to do these things.

Many states set aside wild-life refuge places. No one can hunt in these places

Gendreau

CONNECTICUT
STATE-LEASED
WILDLIFE
REFUGE
HUNTING
FORBIDDEN
STATE BOARD OF FISHERIES AND GAME
PENALTY FOR REMOVING OR DEFACING $100.00

There are more than six million hunting and fishing licenses made out each year. Most of these men and women are real sportsmen. They love to hunt. They love to fish. But they do not wish to kill more animals or catch more fish than they will use. They want to save our wild life, not destroy it.

We are proud of such sportsmen. They play the game right. They live up to the rules. We want them to help the rest of the hunters and fishermen to become good sportsmen like themselves.

These sportsmen have helped to pass laws to protect wild life. Fish are being grown and placed in the streams so that there will be enough fish for the fishermen and more too.

Many large parks and forests have been set aside as places for birds and other animals to live. Here animals can find food. Here they can build homes and raise their young without danger of the killer. No hunting or fishing can be done in these forests. During the cold winter the animals are fed.

Large grassy places have been set aside for the buffaloes. Ponds and lakes have been protected so that the wild ducks and other birds may find food and places to raise their young. Some of the swamps that were drained are now being made back into swamplands for the birds.

Wild flowers are also being saved in these same swamps and parks and forests. Flowers are growing there. No one is allowed to pick them.

The government has done other things to save wild flowers. You can find out what flowers are in most need of protection. You can find out which flowers you may pick.

Many people have formed clubs and societies to help protect wild life. These people wish to have everyone help. You can help by learning all you can about how to grow flowers, when to pick a few, when not to pick any. You can also help by learning all you can about where animals build their homes, what they eat, and how they care for their young.

After all, it is up to each of us to help. Laws can be passed and have been. But, if all of us help, there will be no need for such laws in the future.

THINGS TO THINK ABOUT

The killer has certainly done a great deal of harm to wild life in North America. Many animals that were once common sights are not now to be found anywhere about. Such birds as the passenger pigeon and the heath hen have died out entirely. Prairie chickens have become very rare. Very few wild swans are left.

Swamps have been drained and many of the nesting places of water birds have been destroyed. Wild ducks are becoming scarcer each year, because their homes have been destroyed.

We cannot go on upsetting things as we are doing and expect our wild life to live through it. Every change that is made by man in field or forest or stream affects the wild life of that place. As we make changes let us try to kill no more wild life than we should.

THINGS TO DO

1. Find out what flowers are rare and need protection. Have an assembly and try to get others interested in saving these flowers.

2. Take walks to enjoy the wild flowers as they grow in fields and woods. Leave them there for others to enjoy. Do not pick them.

3. Feed the birds and other animals which spend the winter near your schoolhouse. If you live in a cold climate, you can do a great deal of good by feeding the animals near you. Many of them starve when food gets scarce.

4. Perhaps there is a fish hatchery near enough for you to visit. Here you will see thousands of baby fishes being raised. When they are large enough they are placed in streams and lakes all over the country.

5. There are some animals that have become rare and others that have died out in America since the white man settled here. You may want to read the story of some of these animals. The last passenger pigeon died in 1914. One hundred years ago this bird was very common. Heath hens have also died out. The wild ducks, which are still common, are in danger of having the same thing happen to them, because so many of their breeding places have been destroyed.

RIVERS AND THEIR FLOODS

Floods are not new in North America. Many of our large rivers have had floods ever since we knew anything about them. The Ohio and the Mississippi flooded when the Indians lived here.

Rains often fall too fast and hard at one time, and then do not fall at all at other times. Floods happen when the raindrops of the heavy rains can't all get into the stream at one time. The river runs out of its banks, and rushes along over cities and fields and valleys to the sea.

Floods do a great deal of damage. They often flow into the streets of large cities and kill people and destroy stores and houses and other buildings. Sometimes large cities are completely destroyed by floods. When this happens millions of dollars' worth of damage is done.

Floods are not good for most farmers. The heavy rains wash the soil from the hillsides and fields down to the valley below. Some of the soil that used to be spread out over the farmland is now piled up along the banks of the stream. Some of it is carried down the stream.

In either case the farmer's land is poorer. He needed the soil that was washed away for his crops. It is now lost to him forever. He cannot bring it back to his farm.

The soil that is carried along down the stream often causes trouble. It piles up farther down and at the mouth of the stream. The rivers then become shallow at these places. Boats that used to carry goods up and down the streams can no longer get past the piles of sand. A great deal of money is spent every year to take the sand piles out of the rivers, so that boats may go up and down.

In 1927 the Mississippi had a big flood. Two hundred forty-six persons were killed. Thousands of homes were destroyed. Miles and miles of land were covered with water.

Floods happen every year. Large floods happen every few years. They happen more often now than they used to. Floods are getting worse instead of better in North America. Let us see why.

Again the ax and the plow are part of the story. You have read about how the forests and the grasslands help hold the soil. You know that they slow up the work of wind and water.

Heavy rain storms often wash out bridges like this one

Acme

You also know that many of our forests have been cut and our grasslands plowed. The soil was left free to blow about and to wash away. It is little wonder then that floods have become worse.

Of course something had to be done about it. For many years the people along the Mississippi have built levees and dikes to hold back the water. Levees and dikes are walls built of logs, or stones, or dirt, or cement to keep the water back. Today almost two thousand miles of levees have been built along this one great river.

But these high walls cost money. And even then they do not always keep the Mississippi back. It still floods its banks. Sometimes the walls break because of the force of the water. At other times the water rises above the top of the walls and flows out over the land, killing people and destroying cities and farms. Higher floods call for higher walls.

CONTROLLING OUR RIVERS

Although levees have helped to keep rivers from flooding, they are not the only way to keep back the waters of our streams. By replanting our forests we can help to prevent floods.

The carpet of plants and leaves and twigs which forms on the floor of the forest breaks the force of the water. More water can sink into the ground in the forest, because it can trickle slowly through the cover of plants and leaves. Not so much water runs off.

Many farmers have helped to keep streams from flooding. They are using better ways of plowing their farms. Steep hillsides are being planted to grasses. The water on grassy hillsides does not run off so fast as it does on plowed hillsides. The farmers have come to know that they must keep their topsoil on their land. They know they can do it by farming in the right way.

The more we do to hold back the water of each rainstorm, the more we help to keep floods away. We must help to keep more water on the fields, and let it sink into the ground where it falls.

Air view of Boulder Dam on the Colorado River.
This great dam helps to save the water for use when it is needed

United States Bureau of Reclamation

The water that sinks into the ground is called underground water. This water helps the crops grow in dry weather. But when the water rushes off the land in floods there is not so much underground water for plants to use in the dry season. It has all run off to the sea. In these dry seasons the plants die for want of water.

Sometimes dams are built to help hold waters back. They hold the water upstream, so that it may be used in the dry parts of the year. We say the farmers irrigate, or water the land, with the water stored by the dam. As the crops need the water it is sent from the dam downstream and out into ditches built in the fields.

Many large dams have been built on our streams. Dams cost a great deal of money. Yet they are worth what they cost, because they save the water for later use and keep floods from destroying cities and farms.

THINGS TO THINK ABOUT

Floods in our country do a great deal of damage. They destroy cities and farms. They often kill people.

The Nile River in Egypt floods its banks every year. The people who live in Egypt are glad when the floods come. The flood waters of this river bring down topsoil from the mountains and spread it out over the land in the valley. If the Nile did not flood its banks, Egypt would be a part of the great Sahara Desert. The land would not be fertile enough to raise crops. The people would starve.

There is a great difference between the kind of floods that happen on some of our rivers and the Nile River floods. Our floods are higher. The water rushes on and destroys. The Nile River floods do not destroy. They help the land.

THINGS TO DO

1. Read about the building of one of the great dams that have been built on the streams of the country. Find out why this dam was built and how it affects the life of the people living in that part of the country. The story of Boulder Dam on the Colorado River is thrilling. The great new dam on the Columbia River is worth learning about.

2. Look up the history of the floods of one of the rivers of the country. Find out whether the floods on this river are worse than they used to be. Find out what is being done to prevent floods from happening on this river.

Conservation a Big Problem for All of Us

All of us must eat. Most of the foods we eat are raised on the farms of North America. The soil on these farms must be saved. It cannot keep on going into the ocean by tons and tons as it does today. It cannot keep on blowing about from field to field. If it does, there will not be enough good soil left to raise our crops. Our people will starve. Our once rich country will become a great desert.

There was a time when the farmers could move from poor land to better land farther west. That time has passed. There is no new land left. We have settled North America from the Atlantic to the Pacific. What we must do now is to stay at home and make the soil which we have better.

Whose job is it? Can the farmers do it alone? Can the city people do it by themselves? Can you and I do it without the help of others?

Today conservation is a problem for all of us. It is too big a problem for just a few. The governments of the United States and Canada must help. The state governments must help. The farmers must work together. The people of the city must work with others. You and I must learn how we can help, too.

Conservation costs money. Since 1933 the United States and Canadian governments have spent millions of dollars to help save our resources. Some of the money has been used to build large dams to prevent floods. Some of the money has been used to plant trees to hold the soil to the ground. Much money is spent each year to fight forest fires.

A great deal of money has been used to help the farmer. He has been helped to save his farm. In some cases the farmer and his family have been moved to better farm land. Some of his worn-out farm has been planted to grasses, which will some day be used for grazing. Some of it has been planted to forests where wild life can live. Money has been used for fertilizer to make his crops grow better. Gullies have been filled in and seeded to grass or planted to trees. Harmful insects have been killed. These insects attack the farmers' crops and destroy them.

There are about six hundred places in the United States alone where the government is working to show the farmers how best to save the soil on their farms. Many farmers have learned the right way to plow their land. They have learned different ways of farming, so that their farms will give them better crops.

Many forests have been bought by the government and set aside as places where wild life can live and raise its young. Streams have been planted with fish. Wild flowers of all kinds can grow on these government lands.

State governments work with the United States government by helping to pay for the many things which are being done to our soil. Several states often join together to build levees and dams to keep floods from destroying the land. They also work together to fight forest fires.

City governments are helping by keeping streams clear. In many cities the waste from factories and houses is not being sent into the streams. Cities are building parks and ponds where wild life may find safety. They are teaching their people to enjoy but not destroy wild life of all kinds.

Many persons are doing fine things in conservation on their own farms and with their own money. They are protecting wild life from the killer. They are using newer ways of farming, so that their soil will not grow poorer. In some places they are planting trees. Other fields are being turned back to grasslands. These farm lands are giving the farmer good crops. The soil on these farms will grow better instead of poorer as time goes on.

What these fine persons are doing on their farms is what we want to have happen on all other farms. When the farmer does not have money enough to do the work but he himself knows how and wants to do it, the government must help him. On hundreds of farms the farmer is getting such help.

And now for us. What can we do to help? The first thing to do is to learn as much about conservation as we can. The more we know, the better we shall be able to help. We can start helping by working in our own schoolyard and our yard at home. If we live on a farm, we can help our fathers save their soil. Many seedlings planted by boys and girls are now beautiful trees. Many wild flowers have been saved because boys and girls like yourselves haven't picked them. Many birds have been saved because boys have put away their slingshots.

Some of the best farmers we have today learned how to be good farmers in schools like ours. They tended the school gardens. They learned how to test the soil to find out what kind of crops would grow best in it. They learned how to save the soil.

When someone asks us "How shall we save our resources?" our answer may be something like this: "We must all help. Every boy and girl, every man and woman, every farmer and factory-owner, and every sportsman must work with others and with their governments to conserve our great natural resources. We can do it if we will begin at once. It is not yet too late."

THINGS TO THINK ABOUT

After reading this part of your book we hope that you have a picture of what has happened to our natural resources. We hope that you will join with your classmates, your teachers, your parents, and others to work for better ways of both using the resources of North America and of saving some for boys and girls and men and women who will follow you. Our people have made use of the great natural resources that North America offered. People have been fed and clothed. Cities have grown up. We have become a rich country. Yet in using our resources we have been wasters. Our job now is to learn to stop wasting what is left and to correct some of the mistakes which have been made in the past.

IX

Plants

NATURAL GARDENS

MAN-MADE GARDENS

GARDENING is fun. You may want to make a garden this spring. If you want to be a good gardener, you will need to know how to prepare the ground, plant the seeds, and take care of them as they grow.

Before you start to plan your own garden, it might be well to look about you and see what kinds of natural gardens grow near you. Your garden will be a man-made one. But many gardens are not made by man. The forest near you, the swamp, and the field have plants growing in them that were not planted by man. They grew there from seeds that happened to fall there.

The seeds that grow in natural gardens, as well as the ones that grow in your own garden, must have the right kind of soil, the right amount of sunshine, and the right amount of water in order to grow well.

THE PICTURE ON PAGE 301 IS FROM A PAINTING BY FREDERICK CHAPMAN.

Natural Gardens

Have you ever wondered why the plants which grow around your schoolhouse and your home grow there?

Have you ever wondered why other plants grow in the fields and forests around your home?

There are very good reasons why some plants grow in one place and not in other places. As you probably know, plants do not just happen to grow in a certain place. Some plants can grow in warm places and not in cold places. Other plants can grow in dry places and not in wet places. Some plants must have rich soil in which to grow, while others can grow in stony ground. Still other plants grow well in sunny places but not in shady spots.

If you will take a walk around your neighborhood, you will find out which plants grow in sunny places and which ones grow in shady places. There may be a swamp near your home. If you will look at the plants in the swamp, you will find that they are quite different from those that grow in the dry places near by.

Your swamp garden will have some tall grasses growing along the edge where the ground is quite damp. You may find red-winged blackbirds or some other birds flying around among these tall reeds and grasses. Sometimes you will find small willows and swamp oaks growing among the tall grasses, too.

In the wettest part of the swamp, you will find bulrushes and other water plants. Perhaps you go to

Nesmith

You will find these cattails growing in a swamp garden

your swamp to see blue flags or water lilies that grow there in the summer. Other water plants grow in this wet part of the swamp. All the plants you find in your swamp garden are there because they grow well there.

Galloway

Pond gardens usually have beautiful pink and white pond lilies growing in them

You may not be able to visit a swamp garden. Perhaps you have a pond near your schoolhouse. Pond gardens are interesting to study. They are something like swamp gardens.

Your pond garden may have cattails, bulrushes, and shrubs along its shore. Right out in the water, along the shore, you will see other plants. Perhaps you have rowed your boat along the edge of the pond to gather the lovely water lilies which grow there. These plants have long stems, which grow from the bottom of the pond, and large leaves, which float on the top of the water.

You may have gathered water plants from the pond to put into your aquarium at school or at home. These plants give off oxygen to the fish that live in the pond.

Perhaps you fish in the pond near your home. Rock bass, sunfish, and perch may live in your pond. Turtles probably sun themselves on the banks around the edge of the pond. You may scare the frogs as you walk along the banks.

Do you live near a forest? If so, you may want to find out what kinds of plants grow there. Of course you know that trees grow there. Some forests have beech, maple, and elm trees. Some have hickory and oak trees. Some forests have only evergreen trees in them.

The broad branches and leaves of some of these tall trees catch much of the sunlight. Their roots spread far into the soil and take in some of the plants' material for food-making.

Underneath the tall trees in the forest you will find smaller plants. These are plants which grow well in shady places. They get very little sunlight. You may find ferns with beautiful leaves. You may find small dogwood bushes. You may find many wild flowers tucked in among the ferns. The trillium, violets, buttercups, and other wild flowers may grow there.

You may find mushrooms and puffballs in your forest garden. All the plants which grow beneath the big trees in the forest can grow with very little sunlight. That may be one reason why you find them growing there.

Your forest garden is the home of some animals. Many birds find the forest a fine place in which to build their nests and raise their babies. Squirrels eat the nuts of the oak, beech, and hickory trees and build their homes in the hollow trunks or among the branches of these trees. There may be other animals in your forest. Find out why they live there.

You may want to see what kinds of plants grow in the fields and meadows. The plants that grow in the open country get a great deal of sunlight. They are different from the small plants of the forest garden.

At different times of the year your meadow garden may be full of yellow daisies and blue cornflowers. Goldenrod and sunflowers may be growing there. Grass and thistles will be found there, too.

As you walk in the country, you may frighten a rabbit from its nest in the thick grass. You may find holes in the ground. These holes may be the doors to the homes of chipmunks, gophers, or other meadow animals. The meadow larks, crows, blackbirds, or other seed-eaters will live here where they can get their food.

The plants in the meadow gardens grow there because they are able to grow well in the bright sunlight. They can grow in drier places than some of the forest plants can.

Some plants can grow in places where there are many rocks. These plants are the kind that need very little soil and water. They have thick stems, which hold the little water that they do get from the soil. Their roots spread out in many directions.

These daisies grow in open meadow gardens.
They need a good deal of sun in order to grow well

Roberts

There are some plants which can grow in desert places. These plants are able to grow where it is hot and dry because they have stems which hold water and roots which spread out far and wide to get every bit of water they can.

Your schoolhouse may be near a desert garden. If it is, you know the cactus plant and sagebrush very well. You know what very thick stems the cactus plant has. Very little water can evaporate from these stems.

Perhaps you live among the mountains. If the mountains are high enough, you will be able to see the place where the trees stop growing. This place is called timber line. Above it mosses and lichens can grow.

So it is. Wherever you happen to live—in the cold north or in the warm south, in cold, wet places or in hot, dry places—there are some kinds of plants growing there. These plants are able to grow there because the sunlight, the soil, and the water are right for them. They do not just happen to be there.

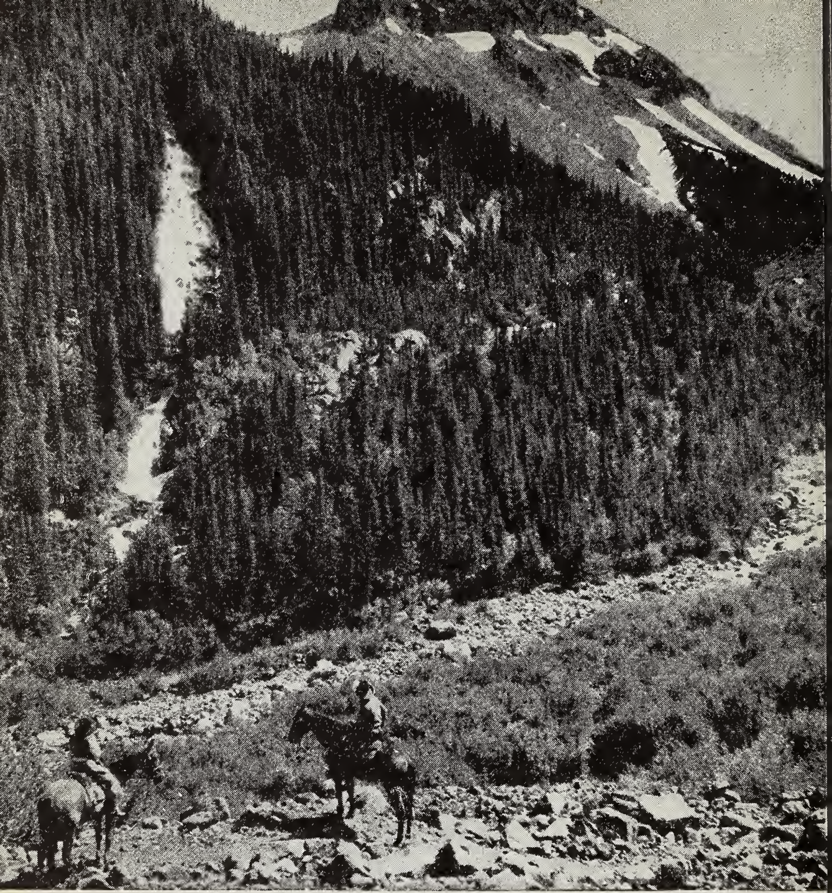
As you know, great changes are always taking place on this earth.

These mosses and lichens can grow where there is very little soil

Lynwood Chace

Galloway

These giant cacti are part of the National Monument in Tucson, Arizona



Galloway

Can you find the timber line in these mountains?

Some of our hot, dry deserts were once cool forest and meadow lands. Some of our fine farm lands were once covered by a thick sheet of ice. Some of the places that were once mountains are now flat and low plains. Such changes are taking place so slowly that we do not notice them. But, even so, they affect the kinds of plants that grow in any place.

Plants and animals living in a certain place may sometimes become changed to suit the changes in heat, light, and moisture there. Scientists say that these plants and animals become *adapted* to the changed conditions. Such changes in plants or animals do not take place in the life of one plant or animal. It may take centuries for some plants and animals to become changed.

Down through the past, plants have kept changing and changing. Many of the huge ferns of olden times have become smaller and smaller. The trees we now have may not have looked the same thousands of years ago. They have changed as the heat, light, and moisture of the places where they lived have changed.

Plants do not always change quickly enough for their new homes. In this case they die out, or, as scientists say, they become extinct. Many plants that used to live upon the earth have become extinct.

Try this experiment and see what happens: Gather some water plants from a pond. Be sure that you take plants that there are plenty of in the pond. Never pick plants that are scarce. Put them on the window sill overnight. When you come to school next morning, look at them. Are these plants doing well?

On the same day put a plant that is growing in soil into a pail of water so that no part of it is above the water. Look at it from time to time. What has happened to it?

THINGS TO THINK ABOUT

1. Think of the different kinds of natural gardens you have seen. Why did certain plants grow in certain places?

2. Perhaps you live in a part of the country that is different from any described here. If you do, try to find out all you can about why those plants which grow where you live are found there rather than some other plants.

THINGS TO DO

1. Notice the different kinds of animals that live in the natural gardens nearest to your school. Watch the animals and find out what they eat and where they build their homes. These two things will help you to know why they live where they do.

2. Perhaps you may wish to make a winter garden to give your mother for Christmas. Use a small glass bowl. Gather moss, ferns, wintergreen plants, and other small plants that grow on the floor of the forest. Water the garden well. Cover it with a glass plate. The plate will keep the moisture inside the bowl from evaporating into the air. You will not need to add much water to your winter garden.

Man-made Gardens

You have been reading about natural gardens, which man did not plant. Let us now read about some man-made gardens. These gardens do not just happen to grow. They are planted by man. Some of the man-made gardens are flower gardens. Some of them are vegetable gardens.

If you wish to have a garden, there are certain things you should do. First of all, you should choose a good garden spot for the kind of garden you want. If you want to have a vegetable garden, you will need a place which has the right kind of soil and the right amount of sunlight for the kind of plants you wish to grow. If you are going to have a flower garden in the form of a rock garden, you will have to know what plants will grow well between rocks and on slopes.

If you have decided upon the kind of garden you wish to have, then you are ready to plan for it. You will have to know something about the kind of soil in your garden plot. Good gardens do not grow in all soils. Some kinds of soil do not have the right materials from which plants make food. So you will need to test your soil.

There are several kinds of materials found in soil. Sand, clay, silt, and gravel are found in soil. These four materials are all formed from rocks. As the pieces of rock break off and wear away, they become ground, or soil. The coarse material is gravel. The finer material is sand. The very fine material is silt or clay.

Galloway

This fine vegetable garden is watered through pipes.
Don't you wish the plants in your garden looked like this?

Gravel is a very poor kind of ground for a garden. In fact, you would never use a gravel pit for a garden. Plants would not grow there. They could not get enough food to live upon. Gravel is useful to man for road-building, but not for gardening.

Sand is much finer than gravel. It is a better kind of ground than gravel for gardens. But a good garden does not grow in sand alone. If your garden plot is very sandy, you will have to choose your plants carefully. Beans will grow well in it, but onions will not.

Most garden spots have some sand in them. And they should. But sand alone does not make so good a soil as sand mixed with other materials.

Clay is very fine earth material. It is a powder when dry, and becomes very sticky when wet. Clay mixed with sand often makes good garden soil. The sand helps to keep the clay from becoming so sticky when wet. But clay alone is not usually thought of as good garden soil.

Silt is very, very finely worn rock. It is so fine that it is often carried along in streams. Whenever you see a muddy stream, you know that silt is being carried along in it. In this way rivers carry good soil from farms. Sometimes most of the good soil is washed away by them.

After a region, or part of the country, has been flooded and the flood waters have gone away, you often see a layer of silt on top of the rest of the soil. It is so fine that the stream drops it last. Silt is a good kind of soil to mix with sand and clay in gardens.

Many gardeners like to have some loam in their soil. Loam is clay, sand, and decayed plant matter mixed together. The plant matter comes from leaves, stems, and roots of plants which decay and become part of the soil. Plants use the decayed matter for making food.

No doubt you can see why decayed plants make good soil. They furnish food for growing plants. So if you are gardening, you will want to have loam in your soil. A mixture of loam, sand, and clay makes good garden soil for many plants.

You may wish to test your soil to see what it has in it. Put a handful of the soil into a fruit jar. Fill the jar about half full of water. Shake it well, and then let the jar stand overnight. In the morning you will find that the soil is in layers. The coarse soil is at the bottom. The fine soil is at the top.

If there is any gravel in the soil, it will form a layer at the very bottom of the jar. This layer may be thick or thin. A thick layer of gravel may mean that there is too much gravel in your garden.

On top of the gravel there may be a layer of sand or clay or a mixture of the two. The top layer will be silt.

Now the thickest layer of soil in the jar tells you what kind of soil most of your garden has. Too much gravel is not good. Too much sand is not good either. A mixture of sand, clay, and decayed plant material, or loam, is best for gardening.

After you know what kinds of soil there are in your garden spot, you will then be able to find out which kinds of plants will grow there. But you do not have to leave the soil just as you find it. In fact, almost every good gardener tries to improve, or better, his soil. You can do the same thing by using fertilizers. Fertilizers help plants to grow.

Some gardeners fertilize with manure. Others use manufactured fertilizers to improve the soil. Some farmers use wood ashes on their land. Other farmers plow clover or other plants under to improve their gardens. Clover makes a good fertilizer because it puts nitrogen into the soil. Plants cannot use the nitrogen in the air. They must get it from the soil.

Soil is being made all the time. But it takes a long, long time to make good soil. You should try to keep the soil good and, better still, try to improve it.

Good soil is important in gardening. But this is not all there is to a good garden. You might have fine soil and still have a poor garden. Every garden has to be worked well. First of all, the soil must be plowed, or mixed, before seeds are planted. The plowing mixes the different layers of soil. It also puts air into the soil.

After the seeds have been planted, a garden must be cultivated, or hoed. Working the soil in this way keeps it soft. This makes it easier for water to get into and stay in the soil. It allows air to get into the soil. Roots of plants can grow better in well-watered and air-filled soil. They can grow down to get food-making materials.

A good garden always means work. Good gardens do not just grow. They grow because someone takes time to care for them in the right way.

The amount of sunlight your garden gets is important, too. Some plants need more sunlight to grow well than other plants do. Lettuce, peas, and carrots need more sunlight than pumpkins and watermelons. You must plant only the kinds of seeds in your garden which will grow well in the sunlight which reaches it.

Now go over all the things which help to make a garden grow well:

1. Choose a good spot.
2. Test your soil.
3. Plow and fertilize the soil.
4. Plant those plants which will do well in your soil with the sunlight they will get.
5. Keep the soil well worked, so that plants can grow.

It might be fun to try different kinds of gardens at school. If you have a large yard, or garden spot, you can have several different kinds of gardens.

Some children who moved into a new school helped to make their school ground more beautiful. They got help from a landscape artist in their planning. He came to school and helped the children and the janitors and teachers to plant the shrubs and trees. On the corners of the ground they decided to plant spiraea and syringa shrubs. They planted a blue spruce tree, so they could have a living Christmas tree to light at Christmas time.

Along the sides of the walks they planted bulbs for early blooming, and later they planted pansies and asters. Along the driveway they planted a hedge. There were already two large maple trees on the front lawn, which added to the beauty of the schoolyard. The yard was planted with grass seed; and as the grass grew, the children helped to keep it cut and watered.

Perhaps you can have a garden in your own schoolyard. If you can, try to get animals to live in your

Galloway

The children in this school enjoy the beautiful trees
and shrubs and flowers in their schoolyard

garden. They help to keep your garden free from certain insects. Toads, frogs, and garter snakes are useful in gardens. They eat insects which would be harmful to the garden plants.

Did you ever stop to think about how plants help to make the earth more beautiful? The tall trees, the beautiful flowers, the fine hedges which people plant, all help to make their homes more beautiful. It is a pleasure to find great parks where plants and animals can grow for people to enjoy. Perhaps the ugly rubbish heaps which we see all too often along the roadsides will some day disappear and plants will grow there to add beauty to the land.

THINGS TO THINK ABOUT

1. All plants do not use the same kinds of materials in the soil in making food. Good gardeners and farmers know this. So each year they have a different place for raising each crop. If they planted corn in the same field year after year, the soil might not have enough of the materials which corn uses to make food. Farmers call this changing about of crops rotating their crops in their fields. In this way they help to keep their soil good. One year there may be wheat in a certain field and the next year there may be potatoes or corn or clover in that field.

2. There are many things for you to think about if you want to have a good garden. You must choose the right spot. Then you have to work the soil well. You must plant the right kinds of seeds, and plant good ones. You must be sure that your garden gets enough water. If you are careful about these things, you should have a good garden.

THINGS TO DO

1. Try to make some soil. Rub two rocks together. Can you get much soil in this way? Just think how long it must have taken to get the good soil you have for your garden.

2. You may want to experiment with soil. Put some sand in one glass jar, loam in another, and clay in another. Plant the same kind of seeds in each jar. Watch them every day. See what happens. Which is the best soil for plants to grow in? Do the roots all grow alike? There are several things which plants need in order to grow. What are they?

3. Put a sweet potato in water in a glass jar. Watch it grow. The vine will make a pretty green spot in your room. How long do you think it will grow? Will it have potatoes? Why?

4. Plan a vegetable garden. Be sure to plant foods which are good for you. Green leafy vegetables, such as cabbage, spinach, and lettuce, are fine food to eat. Plan to have peas, beans, and tomatoes, too.

5. Look at different kinds of plants and find out how these plants are adapted to living in the region in which they live.

6. Notice what kinds of animals live in your garden. See if you can find out what they eat. You will then know whether they are good for your garden.

X

The Energy Man Uses

WHERE DO YOU GET YOUR ENERGY?

SOME ENERGY COMES FROM ANIMALS

SOME ENERGY COMES FROM WATER AND AIR

MAN USES THE ENERGY OF HEAT

MAN USES MAGNETISM AND ELECTRICITY

ALL fine, healthy boys and girls are full of energy. They just cannot stay still for long. Every waking moment they are on the go. Grown-up persons are pretty busy, too. Perhaps they cannot run quite so fast as they used to, but they still keep right on going.

Every move that you make takes energy. All the work of the world takes energy. In fact, energy makes work possible. You cannot row a boat over the blue lake, or skate on the icy pond, or carry a basket of groceries without using energy. Your mother uses energy when she cooks a good supper for you. Your father uses energy when he mows the lawn or washes the car.

Where does this energy come from?

How do you get it when you need it?

What happens to it after you have used it?

These questions will be answered on the following pages.

THE PICTURE ON PAGE 327 IS FROM A PAINTING BY BEN STAHL.

Where Do You Get Your Energy?

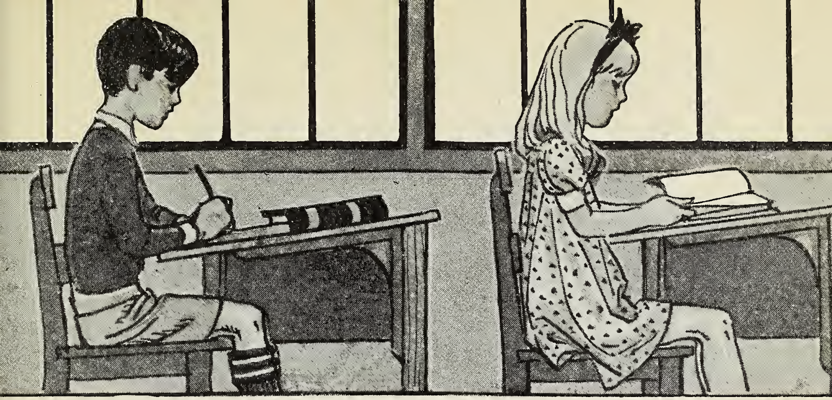
Every move you make takes energy. You walk to school and back home again. Walking takes energy. You play baseball, tennis, or football. These games take energy. When you row a boat or climb upstairs or study your lesson, you use energy to do the work. Even when you sleep you use some energy. Where does the energy come from?

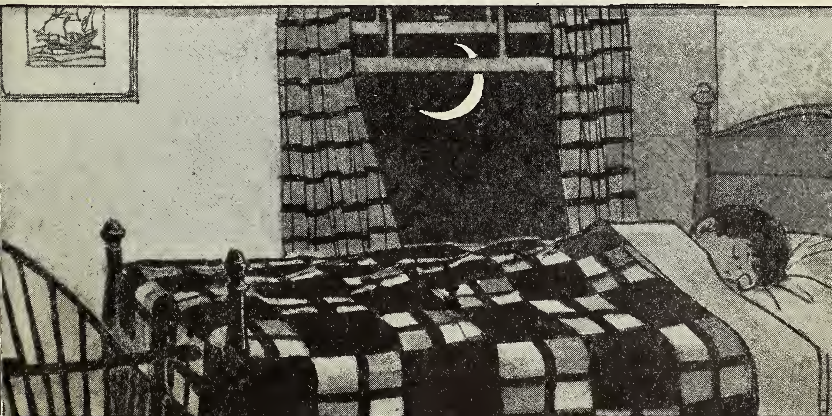
You ate a good breakfast this morning,—perhaps some fruit juice, creamy cereal, buttered toast, and rich milk. These foods gave you some energy. They had energy stored in them. When you ate these foods, you got the energy to do your work.

How did these foods have energy stored away for you? They got it from the sun. The cereal and toast were made of grain. The grain grew in the field because the sun shone upon it. The sunshine gave the grain energy to grow; and when you ate your breakfast, you used some of the energy which the sun had given. The sun gives out a great deal of energy. Energy from the sun is used by plants and animals in their food.

Energy from the sun is stored in water. Energy from the sun is stored in plants. A great deal of the sun's energy is stored in boys and girls and men and women.

You use this energy in your work and in your play. You use it when you grow. Some of the energy you have is used to keep your bodies healthy. Much of the energy you get from foods is used to keep you warm.





The butter, bread, potatoes, and meat which you eat are the fuels for your body, just as coal is the fuel for your furnace.

Some Energy Comes from Animals

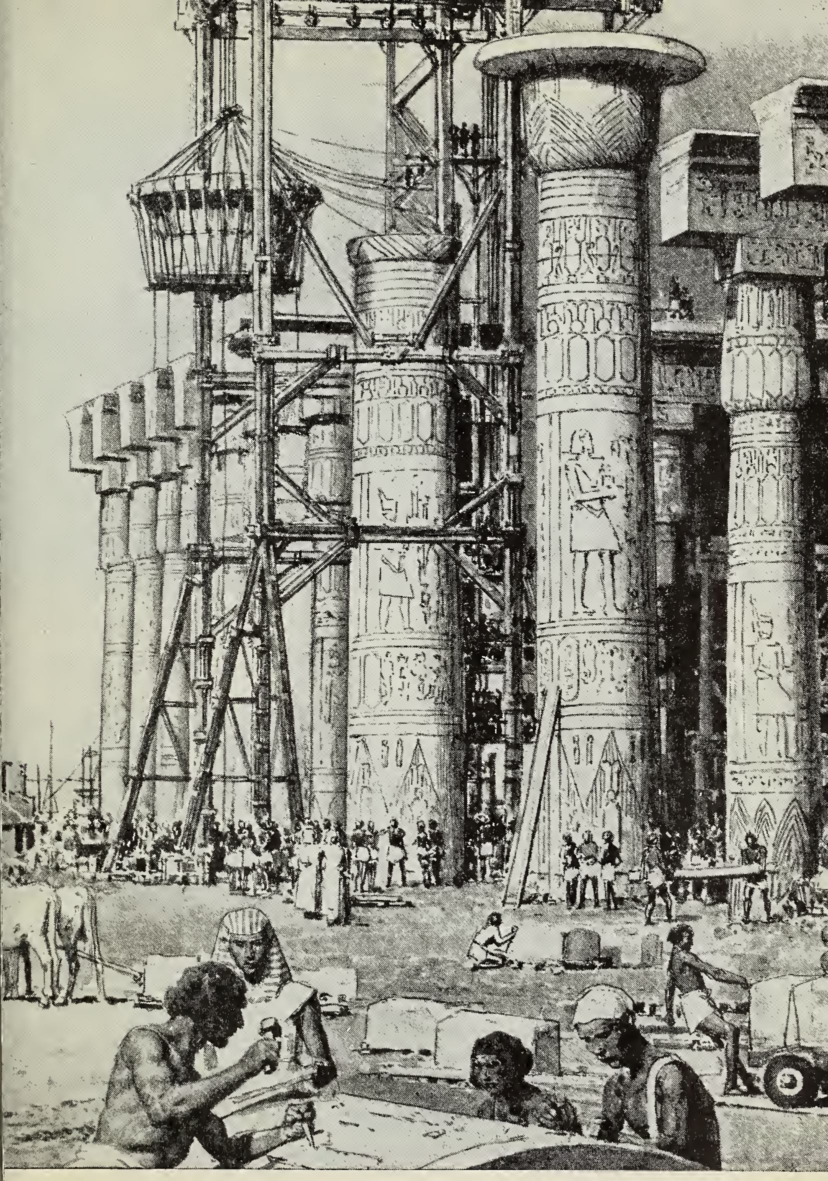
You are a source of power. You have power to do certain work. For a long time after man first came upon the earth he did almost all his own work or got his family and neighbors to help him. He still does a great many things for himself.

Man first hunted his own food. He caught the fish in the stream. He killed the animals with stones and clubs. He built his own boat and paddled it in the water. The women of the tribe had to carry the wood, build the fires, and cook the food.

When there was some large object to lift, one man would get others to help him. Sometimes several men together carried loads on long poles. At other times they worked alone, using baskets to carry loads of fruit, vegetables, or wood.

The great pyramids of Egypt were built more than four thousand years ago by man power. The fastest boats on the Mediterranean Sea in olden times were rowed by many men. Many large barns and houses were built by man power.

As time went on, man came to use animals to help him to do his hard work. In the deserts of Africa and Asia, the camel helped man in carrying his loads. The



The great Temple of Karnak was built by man power

Oxen were used a great deal to help the pioneers of North America

elephant did the same in India. The ox, the horse, and the mule all came to work for him. In some parts of the world, horses came to be used a great deal to do man's hard work for him. Even today, in spite of the automobile, horses are still used. They still pull plows in the fields of the small farmers. They still haul wagons that carry loads of various kinds. Horses will always be of some use to man.

The ox has been a most useful animal to man. Because of its great strength it was used to pull great loads. In the early days of our country, the ox was a most useful animal to the pioneers as they moved farther west.

Burros, or donkeys, are the pack animals of the hilly parts of Mexico and Europe and in the Rocky Mountains. They are used in the mountains because they can climb so well.

In some countries, the dog helps man to do his work. In Holland and Belgium, dogs are used to pull milk and vegetable carts. The explorers of the polar lands use dogs, called huskies, to pull their sleds for them.

Every part of the world has its pack animals. As you travel over the earth, you see these animals working for man.

How do these animals get their energy? They get it the same way you get yours. They eat plants or other animals which eat plants. The plants have some of the sun's energy stored in them. When animals eat the

A team of huskies pulls the supplies of the people who live in the Far North

Galloway

plants, they really take into their bodies energy which came from the sun.

Some of this energy is used to build strong bodies for them, so that they can move from place to place and carry loads. Much of it is used to keep them warm, just as much of the energy you get from your food is used to keep you warm.

THINGS TO THINK ABOUT

1. Did you ever stop to think about how much energy the sun must have? That great star is full of energy. We get only a small part of it here on our earth. Yet this small part is enough to make possible many things. Without energy, no work could be done. People could not work. Other animals would not be able to work for us. Plants could not grow.

2. Every other star has energy, too, just as our sun has. But we cannot use the energy of other stars, because they are so very, very far away from us.

THINGS TO DO

1. Since you now know how very important energy is and that food gives it to you, your class might like to find out what kinds of food give you energy.

2. If you live in a cold region, will your food be the same as that of children who live in warmer places?

3. Can you find out which foods give you warmth?

4. Can you find out which foods help you to build strong bones and teeth?

Some Energy Comes from Water and Air

ENERGY FROM WATER

Have you ever made water work for you? After a hard rain it is fun to put on your rubber boots and go outdoors to sail boats. The water will be rushing along the gutter. You do not need a real boat. A chip of wood or a rubber ball are quite as good. If you have ever played boats after a rain, you have let water work for you.

Or perhaps you have rowed upstream to go fishing. On the way home you let the boat go downstream by itself. You let the water do your work for you.

Man makes water work for him. This is possible because of the sun and gravity. The heat of the sun makes water evaporate, so that it is turned into vapor. The vapor becomes cool and condenses into droplets of water, which form clouds. As more vapor condenses and the droplets become larger, the pull of gravity brings them down to the ground in the form of rain. This has been going on ever since there has been any water on the earth. It will keep right on happening as long as there is water on the earth. Water has energy stored in it. Much of this energy has come from the sun.

For a long time, man has used water to do some of his work. Water wheels were in use in early times. Water wheels were placed at or near a falls in a stream.

The water wheels turned machines in mills, which ground grain for the people. You know that gravity makes water flow downhill. The force of the water, as gravity pulled it down over the falls, was able to turn the water wheels.

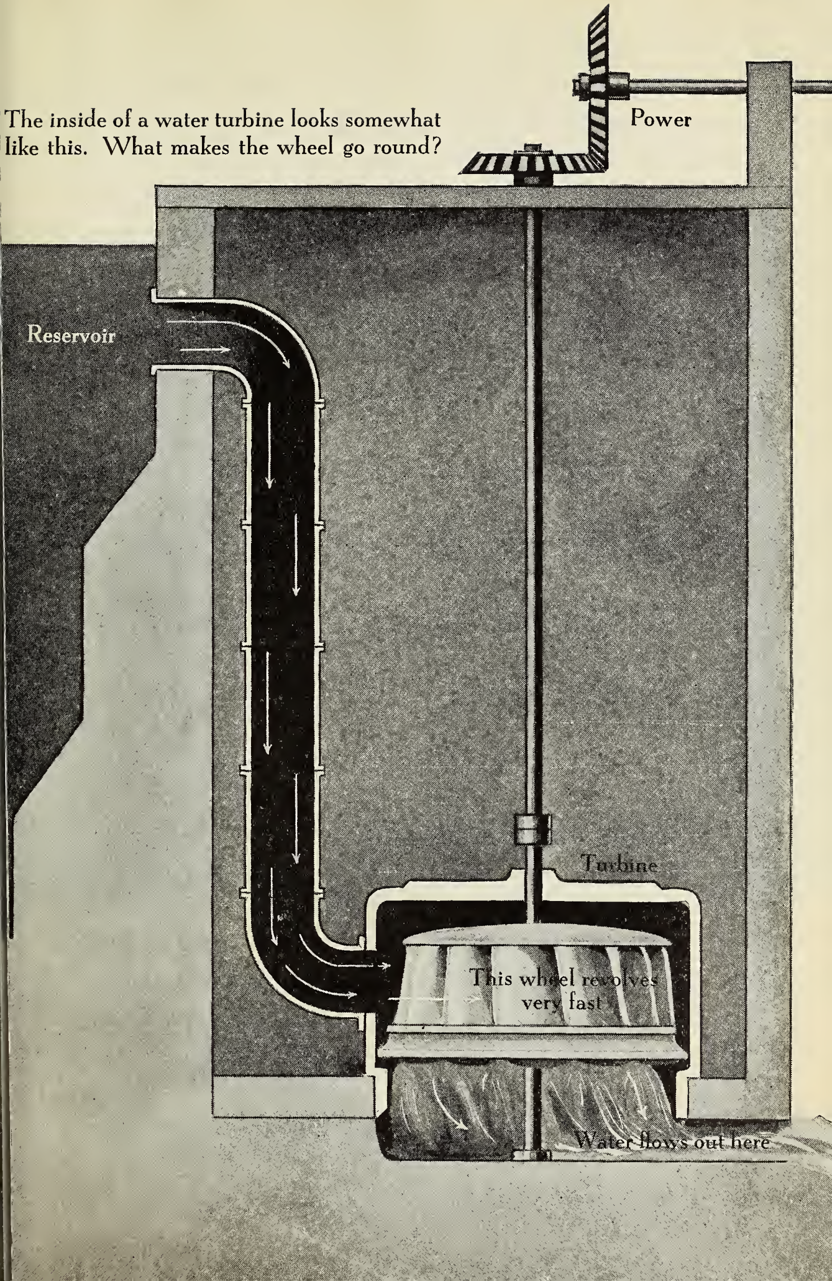
You may have stopped along a country road to look at some old wooden water wheel which is no longer in use. Perhaps you have seen one which still works. Some of them still grind wheat into flour.

Today, instead of the old water wheels, we use water turbines. A water turbine is something like an old water wheel grown up. It is made of steel instead of wood. The picture shows how a water turbine is built and works. Turbines are placed below the waterfalls. The water goes through a pipe from the falls to the turbine.

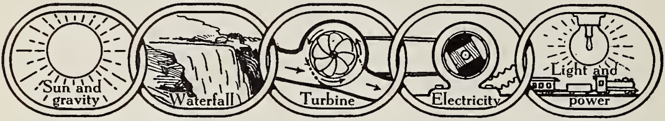
In days gone by, the energy from a water wheel was often used in the grinding of grain. That is, the energy of the water made the wheel turn; the wheel turned two big flat but rough stones called millstones; and the millstones ground the grain between them. Of course you know where the water got its energy. Here is a picture of the way the energy traveled:

Sun + gravity → made water power → turned wheel → turned millstones → ground the grain into flour

The inside of a water turbine looks somewhat like this. What makes the wheel go round?



The water turbines of today are often used to run big machines called generators. Generators make electricity for you. You may use the electricity to light your home, make your toast, iron your dresses, or run your electric train. Here is a picture of the way the energy travels in making and using electricity:



Sun + gravity → makes water power → runs turbine → runs generator → makes electricity → lights your home etc.

ENERGY FROM AIR

Did you ever fly a kite? Some spring day when the wind is strong, get a ball of string and tie it to a kite. Then up goes the kite. Wind helps you to fly it. Wind works for you by keeping the kite up in the air.

Man has long used moving air, called wind, to do some of his work for him. The air gets its power from the sun and gravity. The sun heats the air unequally, so that part of it is warm and light and part is cool and heavy. Gravity pulls the heavy, cool air down and so pushes the warm, light air up. The movement of air caused by the sun's heat and by gravity is wind.

You have watched the wind work for others. Wind must have helped you sometimes. When you walk with

Keystone

Cattle come to drink the water that is pumped by the windmill on the farm

the wind, it pushes you along ahead of it. If you walk into the wind, you have to push hard against it.

Out in the country you often see windmills. They were once more common than they are now. The wind turns the big wheel, and the wheel pumps the water out of the well. The people living in prairie lands use windmills to pump water for their herds of cattle.

In Holland windmills were once used to pump water from the land back into the canals. Today, in Holland, electric engines do much of the pumping which the windmills used to do.

Wind is useful to man in carrying seeds. Every year it picks up thousands of seeds from one place and carries them to other places. If wind did not blow seeds about, you would not find the same kinds of plants in so many different places.

Sometimes winds blow the seeds of plants which are harmful to man. The milkweed seeds scatter with the winds. Thistle seeds are also spread by the wind. In this case, man has to fight against the work of the wind.

Man has learned to make air work for him by compressing it. To compress air means to crowd more air into a place than would usually be there.

If you have a bicycle, you make air work for you. You pump air into your tires. This is compressed air. It makes your tires hard.

Your father uses compressed air in his automobile tires. Some big trucks and busses have compressed air brakes so they can be stopped quickly. Most trains have compressed air brakes, too.

THINGS TO THINK ABOUT

Earlier in this book you read how wind and water have changed the earth. They work for man, yet sometimes they work against him. Try to think of all the ways in which they help man and all the ways in which they do not help man. Your list might start this way:

Ways Wind and Water Help Man	*Ways Wind and Water Do Not Help Man*
1. Winds scatter seeds about.	1. Floods destroy men's homes and crops.
2. Water makes power to run factories.	2. Winds sometimes blow down men's buildings.

Can you go on with these two lists?

THINGS TO DO

1. See for yourself that compressed air has force. Blow up a balloon. Hold your hand over the opening. Feel the pressure of the air as it rushes out of the balloon.

2. Make pictures showing what happens on a windy March day.

Man Uses the Energy of Heat

Did you ever stop to think that heat is very useful to you? It keeps your house warm in winter. Mother uses it for cooking your food, for ironing your clothes, and for making your toast. Your life would be very different without heat.

Heat is a kind of energy. We get some of the heat we need by burning fuel. Wood, coal, and oil are used as fuel. These fuels are often used to turn water into steam. Today steam does a great amount of work for us.

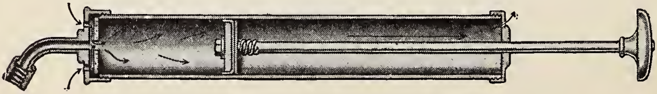
When you boil water, it changes to steam. Water boils at 212° Fahrenheit. A little water makes a great deal of steam. One quart of water makes about 1750 quarts of steam. The steam has a great deal of pressure, or power, until it has spread out into a space 1750 times as big as the quart measure which held the water.

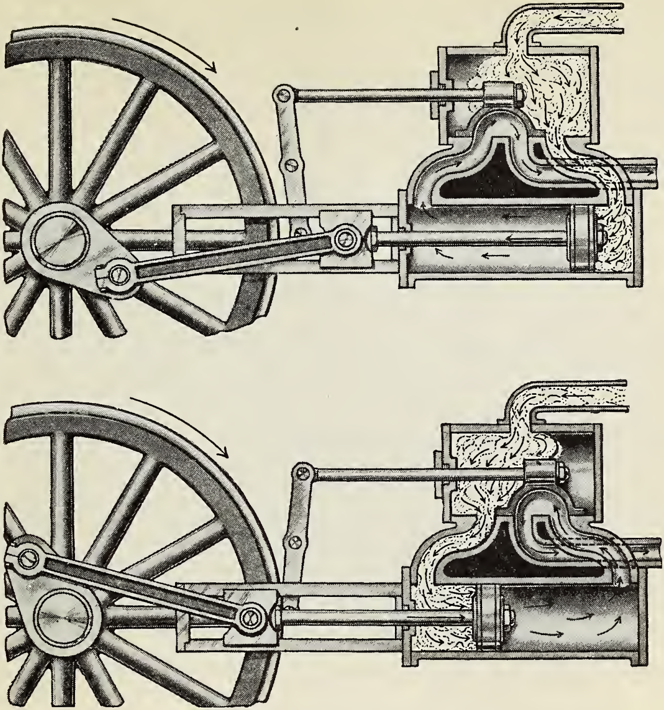
James Watt was only a boy when he discovered that steam has power. He noticed that as the water in his mother's teakettle boiled, the steam moved the lid up and down. He experimented with steam and later used it.

The steam engines we have today use this same power of steam. Let us see how a steam engine works.

Have you ever used an air pump to pump up your football when it needed air? If you have, you know what a cylinder and piston look like.

The inside of this cylinder contains a piston and a piston rod





Looking into the cylinder of a steam engine. Follow the direction of the arrows. What pushes the piston back and forth?

Look at the bicycle pump in the picture on page 342. The round part of the pump is called a cylinder. Inside the cylinder there is a rod with a flat part at the bottom. This rod is a piston rod. The flat part at the bottom is a piston. The piston fits closely into the cylinder.

Find the cylinder of the steam locomotive in the picture on this page. The piston is pushed back and forth in this cylinder by the steam. There are two openings, or doors, in the cylinder to let in the steam.

When the piston rod is nearly to the end of the cylinder, the door near it opens. This lets the steam in on one side of the piston. The steam fills the space on this side and tries to get out. It pushes the piston back to the other end of the cylinder to make room for itself.

Now the door at the other end opens, and the steam which enters there tries to get out, too. It pushes the piston back again. The steam coming in can push the piston back because used steam on the other side of the piston goes out through a pipe.

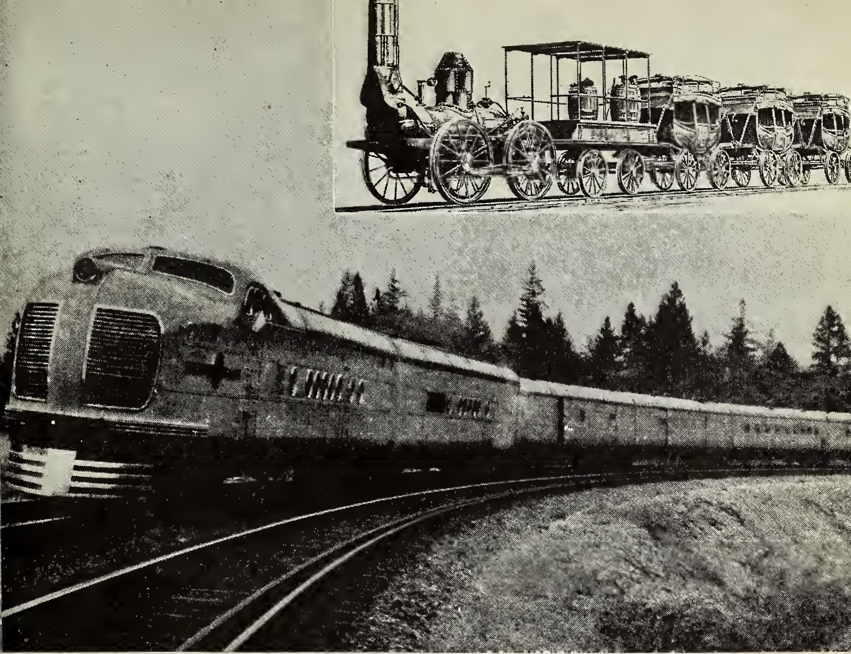
Back and forth goes the piston. Another rod is fastened to the piston rod. It is called a connecting rod, because it joins the piston rod to the big driving wheel. As the steam works the piston in and out, it also works the rod and turns the wheel.

Try to find the piston rod and cylinder at work on the next steam engine you see. Remember the following:

1. When water is heated, it forms steam.
2. Steam needs more room than it has in the cylinder.
3. It pushes the piston back and forth in order to make more room.
4. The piston rod works the connecting rod.
5. The connecting rod turns the wheel.

We use steam to run our great locomotives. These engines pull long trains of cars from one end of the land to the other.

For more than a century, locomotives have been pulling trains of cars. Men have made them stronger and

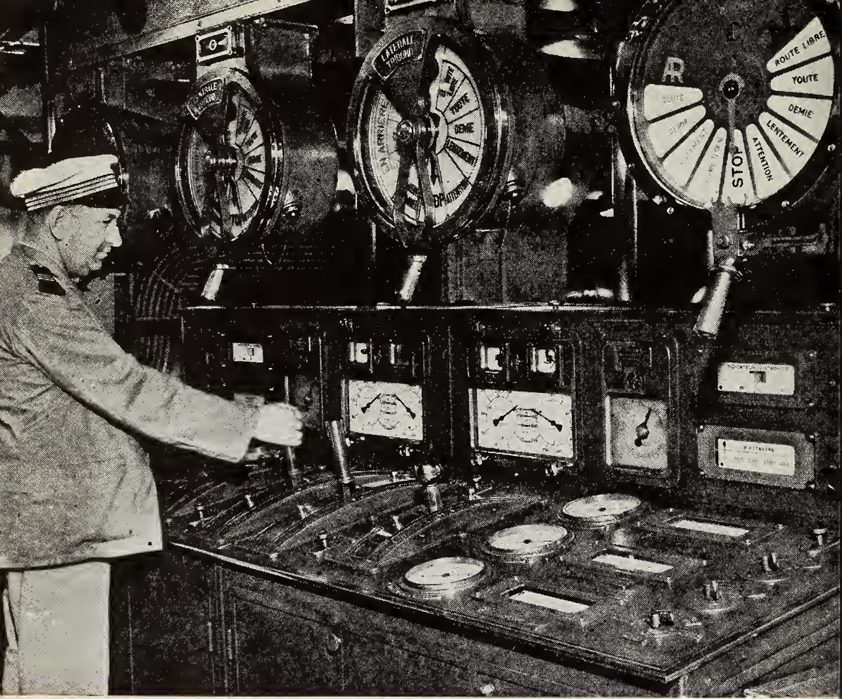


New York Central Railway, Galloway

What a great change there has been in trains in a hundred years! The little train is the *DeWitt Clinton*, which first ran on the New York Central tracks from Albany to Schenectady in 1831

stronger. The picture above shows what changes have taken place in the kind and size of locomotives.

Sometimes steam is used to run big steam turbines. Such turbines are much like the water turbines which you have read about. Instead of using water for power, the steam turbine uses steam. Large factories often use steam turbines to run their great machines. Sometimes these turbines are used to make electricity; and then the electricity runs the machines in the big factories.



Just see how many levers and meters there are in the engine room of a steamship

Steam is used to run huge ships. Perhaps you have seen the letters S. S. written before the name of a large ship. The S. S. means "steamship."

Man uses steam to run large shovels. Have you ever watched one of these steam shovels at work? Sometimes you see men using them to dig up the earth when a new road is being built. Heavy loads can be lifted by these great shovels. The work is done faster when steam is used than when men do it alone.

THINGS TO THINK ABOUT

1. Heat is a kind of energy. You have been reading about how this energy is used by man. It runs factories. Great steam locomotives carry goods and passengers long distances. Big steam turbines make electricity. Ships run by steam carry goods all over the world. Steam shovels dig up the land to make way for bridges, roads, and buildings.

There are other ways in which heat works for us. How many other uses can you think of to add to the list below?

a. Oil burners warm our homes.
b. Gas stoves cook our food.
c. Gasoline runs our automobiles.

2. Coal is our main supply of fuel. Reading about coal will help you to know how very old our earth is. It will also help you to understand what a great source of energy the sun is.

THINGS TO DO

1. Watch your mother's teakettle boil. See if the cover goes up and down. Read about the things James Watt did after he had learned that steam has power.

2. Look for pictures of steam locomotives. Arrange them in your schoolroom so that they will show how locomotives have changed. Try to find a picture of the *De Witt Clinton* or the *Tom Thumb*. These locomotives were very small. Try to get a picture of a large new locomotive, too.

Man Uses Magnetism and Electricity

You must have played with magnets many times. It is fun to watch the toy magnets pick up nails, needles, thumbtacks, and other things made of iron and steel.

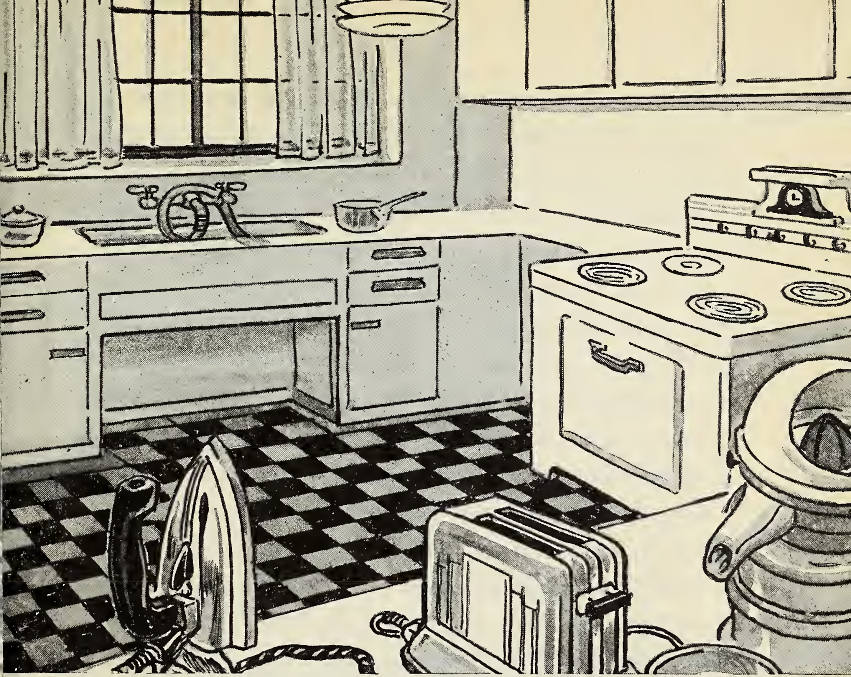
You use magnetism in your play. Man uses magnetism in his work. He uses large magnets to lift heavy machinery for him. Iron can be mined by magnets. The magnets lift the ore right out of the open mines.

Man has learned to make a very useful magnet. It rings our doorbells. It helps us to send telegrams and telephone messages. We call this magnet an electromagnet. We find it useful because we can turn the magnet on when we want to use it, and off when we are through using it. Can you do that with your toy magnet?

It is only during the life of your fathers and mothers that electricity has come to do so much work for man. Our grandfathers and grandmothers got along without it.

You and I today can hardly believe the great changes electricity has made in our way of living. It washes our clothes, bakes our bread, lights our streets, runs our streetcars, carries our messages, and runs our large factories. We call this kind of energy electrical energy.

If you were to make a list of the inventions of the last fifty years, you would find that a great many of them work by electricity. But do not think that electricity is new. It is not. Only man's use of it is new.



Electricity has many uses in a modern kitchen

Electricity has been here ever since the world began. Long ago, men were trying to find out about it. Scientists have been studying electricity for many years. But they have learned how to put it to work only within the last half century.

Scientists do not know just what electricity is. But they do know it is energy and has the power to do much work.

The dry cells in your flashlight make electricity. They do not have electricity stored in them. They have chemicals. When the cells are wired in the right way, the chemical energy in the cells changes into electrical energy. This energy is used to ring your doorbells and to light your flashlights.

Some children think a dry cell has electricity inside it. This is not true. There are chemicals inside the cell. And these chemicals make electrical energy. You can play with this electricity safely. It will not hurt you.

There is another kind of cell, or battery, which is used much more than the dry cell. It is called a storage battery. Your father has one in his car. The energy stored in this battery starts the car. There is a wire running from the starter of the car to the battery and back. This is called a circuit. When your father steps on the starter, the circuit is closed and the engine starts. Ask your father to show you where the battery of the car is. See if you can find the wires which lead to the starter.

Storage batteries are better for some places than dry cells because they can be charged again when they get weak. Dry cells wear out and cannot be charged again.

Perhaps your class could go to a garage near school and find out how storage batteries are charged again. If not, ask your father to take you when he goes to get the battery of his car charged again.

When the battery is connected, the chemical energy in the cells changes into electrical energy.

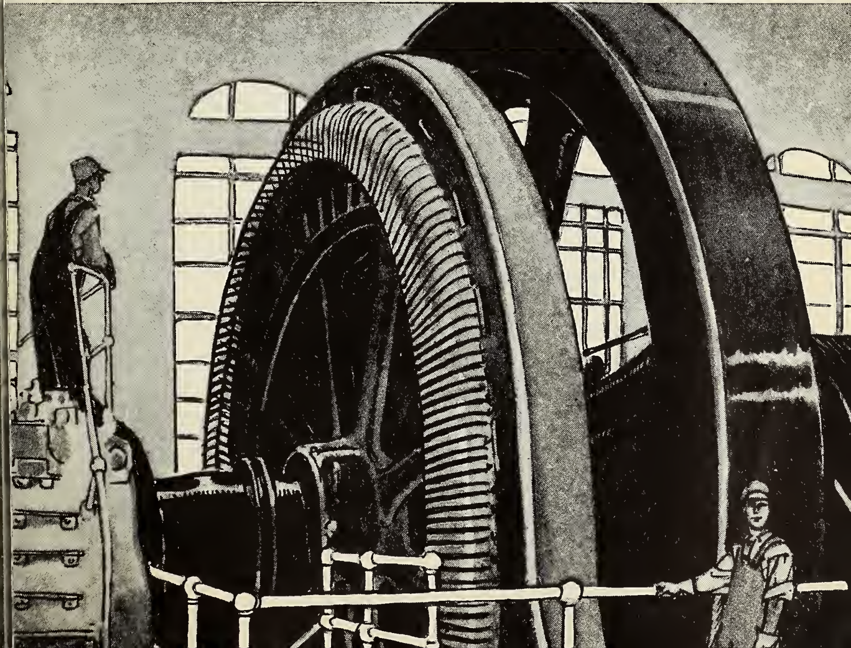
Even storage batteries wear out. They last longer than dry cells, but they will not last forever. Both kinds of cells make electrical energy from chemical energy. And the chemicals are used up after a while.

There is another way to make electricity, and that is by machinery. The electricity that lights your school, that runs your toaster, that runs your radio, is made by machinery. It is made in a power plant. The plant may be many miles from your house. The electricity comes to your house through wires.

The power plant has large machines called generators. These machines make electricity. They are run either by steam turbines or by water turbines, which you have read about.

Power plants are places where one kind of energy is changed into electrical energy. And this electrical

A modern power plant has big, noisy dynamos in it



energy serves you in many ways every day. It runs your trains, elevators, and streetcars. It lights your stores, houses, theaters, and streets. It heats your irons, toasters, coffeepots, and stoves. It runs your electric clocks.

Electricity has become so much a part of our lives that we forget how important it is to us. Just imagine how many things would stop working if electricity were not at hand.

One night not long ago the people of a large city found out how much they needed electricity. There was an explosion at one of the power plants. A part of the city was left without electricity. The street lights went out in that part of the city. Elevators stopped running, and people who lived in high buildings had to walk up many stairs. In hospitals sick patients could not call nurses because the electric call bells would not work. Doctors had to finish their work by flashlights. There could be no motion pictures. Theaters were dark. Streetcars were stopped. Candles were the only light by which hundreds ate their evening meal.

THINGS TO THINK ABOUT

1. Sometimes you hear people say, "We live in a Machine Age" or "We live in a Power Age." Can you think of some reasons why people might say this? Think of the ways machines affect your life. Your shoes were made by machines in a factory. Your clothes were made by machines in other factories. The furniture in your school was not made by hand. It was cut and smoothed and polished by machinery.

When you want to travel, you step on a train or into your car and away you go.

It is true that machines affect your life in many ways. Yet a machine by itself can do nothing. It needs something to run it. It needs power. Sometimes it is steam power, sometimes it is water power, and sometimes it is electrical power that is used to run machines.

Machines have done much good for man. One machine often does the work of a hundred men. This makes it possible to sell things cheaper. When things like shoes are cheaper, we can buy more pairs of them. Or we can buy just as many pairs of shoes as before and use what money we have left to buy books or a radio, or to see motion pictures.

Not so many years ago men and women worked in factories and other places from seven o'clock in the morning until seven in the evening. Most of them had only a half hour for lunch and worked six days a week. Today many factories work only five days a week, the men and women have an hour for lunch, and they stop working at four or five o'clock in the afternoon.

2. Machines have caused trouble too. If one man can run a machine that does the work of a hundred men, what is to become of the other ninety-nine men? For a while some of them may lose their jobs.

But as machines make more things and make them more quickly, things cost less to make. Then the price is cut and people can buy more. As people buy more, the factory needs to make more, and so puts some of the men back to work again.

Some new machines, like automobiles and radios, make new jobs. Slowly many men are working again. They are working fewer days, shorter hours, and can buy more things with their pay.

Man has always used energy to do his work. In days gone by he used his own energy to do much of his work. Later on, man found out better ways of working. He made animals work for him. In this way he got more work done.

From days long past, man has used wind and water to help him to do his work. Finally, he learned about two great forces. They are steam and electricity. As soon as he learned how to make these forces work for him, his life became greatly changed. Steam trains took him all over the land. Steamships carried him across the oceans. He read his books by electric lights. He built large machines and did many things with them.

Science Words

This part of your book is really a science dictionary. It was made to help you to learn the meanings of the science words which are used in your book. When you come upon a new word in science and you wish to find out what that word means, look it up in this science dictionary. It is arranged alphabetically, just as your dictionary is. The *A* words come first; then the *B* words and *C* words follow.

After each word you will find an explanation of it. If you use this science dictionary, you will be better able to understand what you read.

You will also find a number. This number tells you the first page in your book upon which each word was used.

Air. A mixture of gases which we breathe. We live at the bottom of an ocean of air (p. 32)

Air pressure. Air does not seem to weigh anything. Yet all the air above us does weigh something, and it presses down on us. This pressing is called air pressure (p. 128)

Aphid. A small insect which sucks the juice of plants. Ants get some of this juice from aphids and use it as food (p. 174)

Aquarium. A tank or bowl of water in which plants and animals may live (p. 91)

Atmosphere. The part of the earth that is made up of gases. The air is the atmosphere (p. 32)

Battery. You have a battery in your car. This battery supplies electricity (p. 350)

Beebread. Food made by bees for their young to eat after hatching (p. 169)

Boil. When we boil water, it turns into steam (p. 49)

Boll. The seed-holding part of some plants (p. 217)

Carbon dioxide. One of the gases found in the air (p. 118)

Caterpillar. Some insects look somewhat like worms for a time while they are growing up. At this time they are caterpillars (p. 199)

Cell. A small room made by bees for storing food and hatching the eggs (p. 167). Also an electrical battery (p. 350)
Chemical energy. Energy which is made from chemicals. The energy in your dry cell is made from chemicals (p. 350)
Clay. A very fine soil. Clay is very sticky when wet (p. 315)
Clouds. Condensed water vapor in the air. Fog is a cloud. (p. 36)
Cocoon. The cases in which certain insects rest while changing to become grown insects (p. 218)
Compress. To crowd into a small space. You compress air in your bicycle tire (p. 141)
Connecting rod. A rod which joins the piston rod to the driving wheel (p. 344)
Conservation. Saving our resources (p. 296)
Conserve. To save through wise use (p. 238)
Contract. To grow smaller. Metal contracts when it cools (p. 55)
Crop rotation. Farmers plant different kinds of plants in the same field from year to year (p. 261)
Cylinder. A hollow tube. Pumps have cylinders. Engines have cylinders (p. 342)

Decay. Rot. Trees decay after they have fallen (p. 317)
Dinosaur. A kind of animal that lived on the earth a long time ago. Some were very large (p. 76)
Dissolve. When a solid becomes part of a liquid, it is said to dissolve. Sugar dissolves in water (p. 23)
Drones. The males, or fathers, in several insect families (p. 167)
Dry cell. Dry cells furnish electricity. They are sometimes used to ring doorbells and run electric motors (p. 349)
Dye. A color. Clothes can be dyed (p. 222)

Earth. The big ball, or world, on which we live (p. 7)
Earthquake. The shaking of the surface of the earth (p. 63)
Electrical energy. Power of electricity to do work (p. 348)
Electromagnet. A piece of metal which is made into a magnet by electricity (p. 348)
Energy. Power to do work (p. 324)
Erosion. The wearing away of soil or rock by wind or water (p. 83)
Erupt. To throw out. A geyser erupts water and steam (p. 87)

Evaporate. To change from a liquid to a gas (p. 84)

Expand. To spread out or become larger (p. 55)

Extinct. Something which has died out. A volcano can be extinct (p. 104)

Fahrenheit. On the Fahrenheit thermometer water freezes at 32 degrees and boils at 212 degrees. Most of our thermometers are of this kind (p. 47)

Fault. A break in the layers of rock (p. 109)

Female. A mother animal is a female animal (p. 188)

Fertilize. Farmers fertilize the soil when they use materials to make the soil better for growing plants (p. 318)

Fertilizer. Something put on the soil to make it better for raising plants (p. 318)

Fogs. Fogs are clouds near the ground (p. 36)

Gas. A gas is like air. It fills all the space it can (p. 32)

Gaseous. Like gas (p. 35)

Generator. A machine that makes electricity (p. 338)

Geyser. An opening in the earth's surface through which steam and water are often pushed into the air (p. 32)

Gills. Parts of the body which fish use for breathing. Gills are somewhat like our lungs (p. 119)

Glacier. A large amount of snow and ice which has gathered on high mountains. It slowly moves down the mountain as more snow piles on it (p. 92)

Gravel. A very coarse earth material formed from rocks (p. 95)

Gravity. A force which pulls things toward the center of the earth (p. 17)

Hibernate. To sleep part or all of the winter (p. 196)

Ice Age. A time in the history of the earth when it was so cold that ice and snow hundreds of feet deep covered many parts of Europe, Canada, and the United States for many years (p. 94)

Insect. An animal which has six legs and whose body is divided into three parts (p. 167)

Invisible. Cannot be seen (p. 49)

Lava. Melted rock from a volcano (p. 43)
Liquid. Water and oil are liquids. Liquids can be carried about in pails (p. 29)
Loam. A mixture of fine soil and parts of decayed plants (p. 317)

Magnet. A piece of iron or steel which can pull to it other pieces of iron and steel (p. 348)
Magnetism. Power of a magnet to hold some things to it (p. 348)
Male. A father animal is a male animal (p. 188)
Mammals. Animals whose young are fed on their mothers' milk. Mice and elephants are mammals (p. 176)
Manure. A kind of fertilizer (p. 318)
Mercury. A liquid metal used in thermometers (p. 131)
Microscope. When we look through the glass of a microscope, small things look larger (p. 183)
Migrate. Certain animals migrate, or travel, from one place to another at certain times of the year (p. 192)
Molten. Melted, become a liquid (p. 103)

Natural resources. The riches of a country which man found there (p. 244)
Nectar. A sweet liquid found in flowers. Bees use nectar in making honey (p. 169)
Nitrogen. One of the gases found in the air (p. 118)

Oxygen. One of the gases found in the air. We breathe oxygen and use it in our bodies (p. 118)

Pest. A plant or animal which causes trouble because of its numbers is called a pest (p. 234)
Piston. A tight-fitting piece of metal, sometimes covered with leather or other material, which slides back and forth in a cylinder. All automobiles have cylinders and pistons (p. 342)
Piston rod. The long rod fastened to the piston and moving back and forth with it (p. 343)
Planet. A body which revolves around the sun. The earth is a planet (p. 12)
Pollen. A dust found inside flowers (p. 169)

Pollen baskets. The baskets on the hind legs of the worker bees, in which they carry pollen (p. 169)

Pressure. Force against an object. Wind has pressure (p. 42)

Queen bee. A mother bee (p. 167)

Reforestation. Replanting trees where trees have been cut away (p. 275)

Resources. Good soil and fine forests are natural riches of our country. They are called natural resources (p. 238)

Revolve. To turn around, often in the sense of going around in an orbit or circle. The earth revolves around the sun once a year (p. 71)

Rigid. Very steady and firm (p. 42)

Rotation. Turning around as a spinning top. The earth rotates once a day (p. 64)

Sac. A bag used by the worker bee to hold the sweet liquid which it takes from flowers (p. 169)

Sand. Soil formed from rocks (p. 95)

Scientists. Those persons who study carefully to learn the true answers to the questions "How?" and "Why?" about many things (p. 7)

Silt. A fine soil formed from rocks (p. 315)

Social. Those animals are called social that live together in groups. Honeybees are social animals (p. 156)

Solar system. The sun with its planets and their satellites, or moons (p. 142)

Solid. Anything that holds its shape (p. 28)

Solitary. Being alone. A solitary animal is one which lives most of its life alone (p. 164)

Steam. A gas that cannot be seen which is made when water boils (p. 48)

Storage battery. A thing in which chemical energy which can be turned into electrical energy is stored (p. 350)

Stratosphere. All that part of the atmosphere which is more than seven miles above the earth (p. 35)

Termite. One kind of social insect. Termites have homes like ants, but their homes are much larger (p. 180)
Thermometer. We use thermometers to measure heat (p. 47)
Topsoil. The layer of soil at the surface of the earth. It contains food for plants (p. 250)
Turbine. A modern water wheel for making electricity (p. 336)

Universe. The whole world is the universe. The earth, other planets, and stars are part of the universe (p. 26)

Vapor. A cloudlike gas. Steam is a vapor (p. 37)
Ventilate. We ventilate home and school in order that the air may make us feel comfortable and help to keep us well (p. 138)
Ventilator. Any opening used to ventilate a room (p. 136)
Volcano. A mountain which can send out melted rock and gases (p. 43)

Water vapor. When water evaporates, it goes into the air and becomes water vapor (p. 37)
Weathering. Wind and water wear away the land. This is called weathering (p. 102)
Worker bees. The bees that do all the work in the beehive except laying the eggs (p. 167)

Index

WHAT THIS INDEX IS

This Index will help you find the answers to your questions in science. It shows you which pages tell about steam, bees, snakes, gardens, or other things you may wish to study. It is a guide to help you find out quickly what pages to turn to for the things you wish to read.

HOW TO USE THIS INDEX

The Index is arranged like your *ABC's*. That is, words beginning with *A* come first; words beginning with *B* follow; words beginning with *C* come next; and so on.

Suppose you wish to find out about bumblebees. Say your *ABC's*. *B* comes quite near the beginning of the alphabet. You will look for *Bumblebee* toward the beginning of the Index. Look through the Index until you come to the words beginning with the letter *B*. Then look carefully through these words for *Bumblebee*. Have you found it?

Number *171* follows the word. This number tells the page to which you should now turn. Read this page and see what it says about bumblebees.

Perhaps you wish to find out about snakes. *S* comes near the end of the alphabet. Look for the words beginning with the letter *S*. Now look carefully for the word *Snake* in these words. Have you found it? To what page will you turn? Read this page.

Sometimes you will find several numbers after a word in the Index. Find the word *Ants* in your Index. There are several numbers after it. This means that you will find something to read about ants on each of these pages. If you do not find the answer to your question on one page, turn to the next one listed in your Index. Keep on doing this until you do find the page which tells you what you want to know about ants.

It is fun to learn how to use the Index. Practice using it so that you will be able to find the pages quickly. You will be surprised how much time you will save yourself when you can use the Index of this book quickly.

Most of your other schoolbooks also have indexes. They are arranged like the *ABC's*, too. If you learn to use the Index of this book, you will be able to find the things you wish to read about in your other books quickly, too.

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